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The major aims of this conference on guided learning were: (1) to examine research and educational practice relevant to development of a theory of guided learning; (2) to develop a theory and stimulate educational practice and research. Transcripts of the presentations of five speakers and of the ensuing discussion to creative development, a review of recent studies, experiments in the teaching of thought operations, guided learning and the new curriculums, and a theory of guided learning and development. (NH)

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Giving Emphasis to Guided Learning

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Proceedings of the
Conference on Guided Learning
held at the
Educational Research Council
of Greater Cleveland
Cleveland, Ohio
January 23-25, 1966

UD 002 623

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Foreword

This publication reports the proceedings of the Conference on Guided Learning held at the Educational Research Council of Greater Cleveland, Cleveland, Ohio, on January 23-25, 1966. Plans for this conference were developed over a period of time through informal discussions with various investigators in this area, with members of the Educational Research Council staff, and with the Council's Child Development-Preventive Psychiatry Committee.

The conference had two major purposes: (a) to examine research and educational practice as they relate to the development of a theory of guided learning and (b) to discuss the next steps in the formulation of a theory and to stimulate research and educational practice in guided learning. Participants in the conference, in addition to those listed on the program, included members of the Council staff, representatives from the colleges and universities in the Greater Cleveland area, and the superintendents and supervisors of instruction in the Council schools.

A statement of the purposes of the conference was given to each person who registered. A revision of this statement appears in the first chapter. Chapters II through VI contain reproductions of the participants' prepared papers. Small group discussions, in which each person in attendance received an opportunity to question and discuss the topic, followed the presentation of papers by Torrance, Kohnstamm, and Hunt. The chairman of each group then reported to the general assembly and addressed the questions of his group to the speaker. The papers given by Schoer and Gordon were followed by general discussion from the entire group. These discussions were condensed and are presented following the respective papers.

All sessions were recorded on tape with the assistance of Dean Mancini and then were transcribed and edited. Melania Tipnis assisted with the transcriptions, and Florence Keck did the editing and proofreading. Jackie Blecher made many of the arrangements for the Conference and assisted in the preparation and checking of the manuscript. Henry Briggs handled arrangements for publication and advised on graphic design.

The extensive quotations in the paper by Dr. Gordon are cited by permission of the Addison-Wesley Publishing Company, the Biological Sciences Curriculum Study, and the journal, *Perceptual and Motor Skills.*

Sincere gratitude is expressed to all participants in the conference and to all who assisted in the preparation of this report.

RALPH H. OJEMANN, Director
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PROGRAM

Conference on Guided Learning

Educational Research Council of Greater Cleveland
Cleveland, Ohio
January 23-25, 1966

Sunday, January 23

Evening Session

Presiding: Dr. Ralph H. Ojemann, Educational Research Council
Welcome: Dr. George H. Baird, President Educational Research Council
Topic: *Review of Recent Studies Involving Guided Learning*
Dr. Lowell Schoer, Associate Professor, University of Iowa
General Discussion

Monday, January 24

Morning Session

Presiding: Dr. Harold S. Davis, Educational Research Council
Topic: *History of the Concept "Guided Learning" and Its Application in Teaching Convergent and Divergent Thinking*, Dr. E. Paul Torrance, Professor of Educational Psychology, University of Minnesota
Reaction Groups:

Reaction Group I	Chairman, Dr. Frank Laycock
Reaction Group II	Chairman, Dr. Joseph Grosslight
Reaction Group III	Chairman, Dr. Chester McNerney
Reaction Group IV	Chairman, Dr. Elyse Fleming

Reassemble—Discussion

Afternoon Session

Presiding: Dr. A. H. Blankenship, Educational Research Council
Topic: *Experiments in the Teaching of Thought Operations*, Dr. G. A. Kohnstamm, Lecturer, Institute of Education, University of Utrecht, Holland
Reaction Groups:

Reaction Group I	Chairman, Dr. Lawrence Schreiber
Reaction Group II	Chairman, Dr. Jane Kessler
Reaction Group III	Chairman, Dr. Chester McNerney
Reaction Group IV	Chairman, Dr. Karen Pritchett

Reassemble—Discussion

Evening Session

Presiding: Dr. Robert S. Gilchrist, Educational Research Council
Topic: *Guided Learning Experiences and the New Curricula*, Dr. Ira Gordon, Chairman, Foundations of Education, University of Florida
General Discussion

PROGRAM (*Continued*)

Tuesday, January 25

Morning Session

Presiding: Dr. Karen Pritchett, Educational Research Council

Topic: *Toward a Theory of Guided Learning and Development*, Dr. J. McVicker Hunt, Professor of Psychology, University of Illinois.

Reaction Groups:

Reaction Group I	Chairman, Father Glenn F. Williams
Reaction Group II	Chairman, Dr. Bernard Z. Friedlander
Reaction Group III	Chairman, Dr. William H. Farling
Reaction Group IV	Chairman, Dr. James A. Bard
Reaction Group V	Chairman, Dr. Philip R. Merrifield

Reassemble—Discussion

Afternoon Session

Presiding: Dr. Karen Pritchett, Educational Research Council

Discussion of: *The Beginnings of a Theory of Guided Learning*, led by Dr. Ralph H. Ojemann, Educational Research Council

General Discussion—Next Steps

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CHAPTER I

Purpose of Conference on Guided Learning

RALPH H. OJEMANN, DIRECTOR
Child and Educational Psychology—Preventive Psychiatry
Educational Research Council of Greater Cleveland
Cleveland, Ohio

The purpose of this conference is to clarify the meaning and role of guided learning in human development, to assemble the basic investigations in this area together with their applications, and to plan the next steps in stimulating research and theory development in this area.

To make this discussion meaningful it will be necessary to clarify the concept "guided learning." This requires a consideration of the differences between guided learning and other types of learning. Since verbal stimuli are often extensively, but not exclusively, used in the guidance of learning, it will be helpful to keep in mind the role of the various types of stimuli.

An example of guided learning is found in an investigation of the development of the concept "specific gravity" by Ojemann and Pritchett (1963). In this study two methods of developing an understanding of specific gravity are cited. One is the method which is implied in the studies by Piaget (1951). Piaget investigated children's concept of specific gravity by taking subjects of various ages as he found them in the Geneva environment and questioning them as to their ideas concerning which objects would float, which would sink, and why. No detailed information is given as to the background and experiences of these subjects. It is probable that the experiences were such as a child might have in his ordinary daily interactions; and through the process of accommodating to the demands of the environment and assimilating the results of such experiences, he gradually developed the concept at about nine years, according to Piaget.

Ojemann and Pritchett, however, developed a sequence of experiences based on a consideration of the nature of the learner and the nature of the learning product. They queried kindergarten and first-grade children as to their present ideas, then arranged demonstrations so the children could observe for themselves that their explanations were not adequate. This was followed by some experiences which demonstrated that when an object is put into the water, the water "is pushed away" to make room for the object and that this happens regardless of the size of the body of water. Finally it was suggested that the children "might try to see if the weight of the water pushed away" has anything to do with the problem, and some laboratory exercises were planned with the children to investigate this.

In this sequence the learning was "guided" in the sense that the "guide"

—arranged to have a variety of objects available which the class could use in testing the adequacy of their original ideas

—planned some demonstrations of the phenomenon of displacement

—*suggested* that they try to see "if the weight of water displaced had anything to do with the problem."

The "guide" arranged to have a variety of objects available. In ordinary unplanned experience it might take some time before the child would meet such a variety in such a strategic sequence.

The "guide" "turned" the children's attention to the phenomenon of displacement in both small and large bodies of water. Under ordinary conditions it is quite possible that a child would not notice the rise in level in a large body of water for quite some time.

The "guide" suggested they "might try to see if the weight of the water displaced in relation to the weight of the object has anything to do with it." In other words, the guide "pointed the direction" in which explorations might be made. There was a searching by the children and a "discovery" by them, but the direction in which the search was made was not a matter of chance.

Through a series of activities, the "guide" arranged matters so that the children would have a sequence of experiences through which it was hypothesized they would develop the concept. The results of the experiment demonstrated that both the kindergarten and first-grade groups made significant gains over equated control groups, but that is not the point of concern here. The purpose of this example is to assist in clarifying the concept "guided learning." The example demonstrates some of the differences between "guided" learning and the "chance" learning which takes place when the child has only the everyday environment "as it happens to be."

A second example may help to demonstrate some of the differences between a specified "cut-try-reward or punishment" learning and "guided" learning. Suppose we consider the development of the concept "table." Braine (1962) in a recent publication suggested the following procedure for developing this concept: "We tell the subject (or let him discover by experience) we are going to place objects one by one in front of him and that each time he is to make, or refrain from making, a certain response. Sometimes he will get a reward for making this response, sometimes for refrain-ing from making it." Matters are arranged in such a way that he is rewarded only for making the response when there is a table in front of him. When he has learned to make the response only to tables, he is tested with generalization stimuli, which might be, e.g., desks, end tables, sideboards, cocktail tables, and so forth, and we find out how he classifies these.

A "guided" procedure might consist of the following: a consideration of the concept "table" suggests that the important aspects are "flat top" and something akin to "legs" for supporting the top. We want the stimulus "table" (either auditory or visual or both) to evoke the responses represented by the combination of "flat top supported by legs." This is the learning goal or product.

We might show a real table or a picture of a table and at the same time say, "Here is a thing that has a flat top and something that holds up the top." We point to the flat top and "legs." "Such a thing we call a table." Then in order to help the child to disassociate such aspects as color, form, and size, we may show pictures of many different kinds of tables and say, "All of these have flat tops and something to hold up the top. All of these are tables. A table may be of many different colors as you see here (pointing to the pictures) and of many different sizes, and the tops and legs may be of many different shapes." This is accompanied by pointing to the objects and giving the child an opportunity to inspect closely.

Then we might present the child with an assortment of objects — some "real" tables, some pictures of tables, some miniature models of tables — along with other objects and ask him to sort out the tables from the other objects.

The above two examples illustrate some of the aspects of the concept of "guided learning." It may appear to the reader that they are examples of what has been called "convergent" thinking. We could take examples involving essentially divergent thinking as in situations in which the guide suggests, "I don't think we have thought of all the possibilities" and encourages additional hypotheses or approaches.

What other aspects require sharpening? How does the use of guided experiences differ from serial learning, in which the subject is presented with a series of stimuli (often words) together with the appropriate responses, and the series is repeated until a criterion of mastery is reached?

In addition to the clarification of the concept "guided learning" or "guided experiences," there are several other problems. There are examples in the literature of investigators in concept formation who recognize the interaction of experience and organism but then proceed to delineate the development of specified concepts by age or by stages without reference to the experience the organism has had. What is the meaning of this?

There are many examples in the literature in which available knowledge of the effects of guided learning experiences is overlooked. What causes this?

Mathematical models of learning have been developed which contain no parameters designating differences brought about by "chance" experiences and by "guided" experiences in rate of learning. What is the significance of this?

The problem of application of the findings of learning studies to the classroom situation has been a difficult one. It appears that the basic nature of the teacher's work is that of a guide for learning. The vast majority of studies in American psychology have been concerned with conditioning, trial and error discrimination learning, and rote learning. Would more concern with guided learning produce more powerful knowledge of learning?

Are different sequences of experiences necessary, depending upon intrapersonal variables as well as the degree of abstraction of the concept to be attained and the circumstances surrounding its attainment? Bruner has indicated different "strategies" used in concept attainment. How are these learned? Which strategies can be utilized in inquiry training, and under what conditions? How does a child's ability in convergent or divergent thinking influence his choice of strategy and his openness to planned programs utilizing other strategies? In the investigation on the development of the idea of specific gravity some of the subjects in the experimental group made no gain. Why?

A very significant problem relates to the development of a theory or theories of guided experiences. How far has thinking developed in this area? On what aspects of a theory of guided experience is there agreement? What suggestions as to criteria for selecting guided experiences do the agreements suggest? On what theoretical aspects are these disagreements? What do these disagreements suggest as to the next step in research?

The plan of the conference is to consider recent research suggesting some of the possibilities in the use of guided experience in the area of concept development, learning methods of inquiry, attitude formation, and personality development. In each case recent research will be examined, ways of stimulating more logical and intelligent use of the findings suggested, and the next steps in research and theory development proposed.

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Welcome

Dr. Baird:

As I see it, this conference presents us with a very high level opportunity to explore just how far we have come as educators in this whole field of guided learning. There is a possibility that we have enough information and have come far enough to warrant bringing much more radical changes to our schools than has been done in the past, I hope that such is the case and that real progress will result. I hope that, under the guidance of Dr. Ojemann and Dr. Pritchett of our staff, we will be able to work out ways in which we can bring a superior kind of education to our children. If there is enough information uncovered through this conference, we may plan similar kinds of conferences with classroom teachers at a later date. I welcome you to the conference, and I wish you Godspeed and significant results.

CHAPTER II

History of the Concept "Guiding Learning" and its Application in Teaching for Creative Development

E. PAUL TORRANCE*
University of Minnesota

I am not sure through what divergent and convergent thinking processes Ralph Ojemann ever produced the title of my paper, "History of the Concept 'Guiding Learning' and Its Application in Teaching For Creative Development." It presents an exciting challenge, and I wish that I could respond to it adequately. It is certainly appropriate to consider the history of the concept "guided learning" along with its application to the history of educational ideas. Almost all of the significant leaps that I can identify in the direction of a theory of guided learning have occurred along with efforts to bring about a more creative kind of education and to free man's intelligence and spirit to develop and function at a higher level.

Although the relevant research that I have examined has favored the concept of guided learning, the advocate of this concept has usually been misunderstood and rejected and his principles rarely applied in educational practice. He has been caught between the powerful extremes of what I shall call "coerced" learning (i.e., learning by authority, overdirection, force, reproduction, or imitation of a compulsive type) and "unguided" or "laissez-faire" learning with its lack of discipline, direction, and anchors or guides to behavior.

One way of explaining why the concept of guided learning has not prevailed and been more fully developed is that it is more complex, requires more intellectual and emotional energy to implement, and calls for teachers with more training, skill, and imagination than do the two extreme approaches. The human mind seems to crave oversimplification and tends to cope with stress and pressures to change with less expensive energies. Aside from man's nature, there have also been throughout history strong cultural and political forces inimical to the concept of guided learning.

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*I am indebted to my wife, Pansy, for doing most of the reading necessary to prepare this paper.

In China, one of the oldest civilizations with perhaps the first civil service system, the highest grades went to candidates with the greatest memory. Success was not attained through the solution of problems, constructive coping with stress and problems, or originality of thinking. What counted was ability to conform to the style of the ancient and acknowledged masters of literary classics. Every ambitious boy hoped to take these examinations and become a member of the privileged class. With such motivation, the coercive, authoritarian approach to learning prevailed and kept Chinese education from being creative.

In the Hebraic culture, the individual was still subject to external authority. The priestly class retained for itself the privilege of inquiry and study. Some of the older and more brilliant students were encouraged to search out the meaning of what they had learned, provided they did not venture too far from traditional beliefs. Obedience to one's elders was deeply ingrained. Reformers, such as Jesus, saw the superficiality of such a system, but their efforts were never powerful enough to bring about any substantial changes that might have been instrumental to the development and elaboration of the concept of guided learning.

In ancient Greece, the basic aim of Spartan education was the preservation of the folkways. The thoughts and actions of growing youth were carefully controlled through the Spartan educational system. In early Athens, close imitation was a virtue. The Sophists introduced a new type of teaching in which learning was fun but shallow and education was for personal enjoyment. Into this setting came Socrates, who gave the concept of guided learning a big push. Socrates usually began with a casual question about something his student regarded as beyond question: the nature of courage, temperance, or justice (Broudy, 1963, p. 11). In this way the student soon recognized that he really did not know what had previously seemed so certain, that his common-sense definitions led to awkward consequences, and that he was woefully ignorant about the very thing in which he thought himself to be wise. The time was then ripe for the positive side of Socrates' method, dialectical self-examination. Even in an atmosphere of relative intellectual freedom, Socrates had to drink the poison hemlock because of the skepticism and heresy that he stirred up among the youth. Nevertheless, the early Greek thinkers give us one of the first instances of intellectual freedom. One of the finest examples of early Greek skepticism was Xenophanes' discovery that man created the gods in his own image (Robinson, 1921), a concept that has now been expanded into projective psychology and has led to many useful insights concerning man's mental functioning.

In the absorption of Greek culture into the vast Roman Empire, critical and creative thought began to decline. The Roman genius for adaption and application was far greater than any tendencies to originality.

The universities of the Middle Ages emphasized the lecture method and offered no encouragement for critical analysis, initiative, or originality.

Here and there, however, there were other teachers like Socrates, who sought to free intelligence and teach their students the skills of productive thinking and the use of these skills in the acquisition and production of knowledge. Thus, we have men like Comenius, Pestalozzi, Froebel, Spencer, and others who continued to contribute to the development of the concept of guided learning and its application to the teaching for creative development. Each of these innovators had his moments, won his advocates, and set in motion ideas that have continued to develop, but each also met powerful opposition that hindered full development and acceptance. Regarding Froebel, for example, Elizabeth Peabody wrote: "... the reactionary government of Prussia had forbidden the introduction of his Kindergarten into the public school system of education; instinctively divining that an education which recognizes every human being as self-active, and even creative in his moral and intellectual nature, must be fatal, in the end, to all despotic governments" (Barnard, 1879, p. 5).

In this paper, I shall attempt to identify the essential elements of the concept of guided learning and attempt to show how these concepts have been developed, challenged, defended, and tested during the past two or three centuries. I shall also try to show how each of these elements fits into my own research and development regarding the teaching for creative development.

As I have tried to identify the essential elements of guided learning through its emergence in history, it seems clear to me that guided learning has been differentiated from other types of learning by this fact: guided learning has considered the particular nature of the learning task and of the learner — a consideration that other learning approaches have generally ignored or incompletely examined. It is through the positions taken by educational thinkers on issues concerning the nature of the human mind and personality and their functioning, however, that these differences become apparent. Those who have contributed most to the development of the concept of guided learning have generally taken the position that:

1. The human learner is self-acting and creative, requiring guidance and direction but not dictation and coercion.
2. It is natural and healthy for learning to be a continuous process, and it becomes such with appropriate guidance.
3. Human intelligence is not a single function but consists of a union of all of the little functions of discrimination, observation, retention, reasoning, analysis, synthesis, divergent thinking, judgment, and the like.
4. All of these abilities are susceptible to development through learning experiences, function differentially in different learn-

ing tasks and in different ways of learning the same task, and may develop at different rates and to different levels.

5. All learners require that learning tasks have some degree of structure, but the degree of structure required varies greatly among the individual learners.
6. Learning is accomplished most effectively when learning tasks are arranged in some sequence appropriate to the stage of development of the learner, his strategies or skills in learning, and the like.
7. Guidance of learning may be accomplished through a variety of both verbal and non-verbal means, other than through the structure and sequence of the tasks to be learned.

I shall attempt now to trace briefly the history of each of these ideas and show how it enters into the teaching of productive thinking.

SELF-ACTING NATURE OF THE LEARNER

Advocates of both the more coercive and the unguided approaches to learning have characteristically overrated the receptivity of the human mind. The advocates of coercive approaches have held as an ideal the learner who is quiet and passive, accepts and remembers what he is told by authority, and is punctual, orderly, and neat. The advocates of unguided approaches believe, like the advocates of guided learning, that the human learner is self-acting. Since they overrate the receptivity of the learner, however, they fail to recognize the need for guidance and seem to assume that one learns automatically by doing.

Socrates, Plato, Rousseau, Pestalozzi, and Froebel were among the early educational thinkers whose work reflected the concept of learning by doing accompanied by responsiveness to the self-acting learner. Socrates attempted only to help young people think, but he did this so well that it made him and many of his pupils famous. Some of these youths came to him because they were in trouble — in rebellion against the prevailing blind acceptance of traditions and customs — and found no satisfaction in the shallowness of the Sophists. He helped them to formulate their questions, to investigate, and to arrive at conclusions of their own. Other youths came with swagger and conceit. They saw no problems or difficulties. They talked glibly, quoting traditional sayings or the latest word of some Sophist. Socrates would listen patiently (an important guidance act itself). He would then humbly ask them to explain their views more fully so that he might better understand (another important guidance act). The harder these young men tried to explain, the more entangled and confused they became. If they showed an awareness of their ignorance, Socrates then guided them to think carefully and persistently about their perplexities and to reach a satisfactory solution and a well-founded conviction.

The teaching strategy of Socrates is amazingly similar to the guided learning approaches employed in the experimental work of Ojemann (1948) and Ojemann and Pritchett (1963) and in approaches modeled after Festinger's (1957) concept of cognitive dissonance. Since the psychological discomfort arising from an awareness of a problem, difficulty, disharmony, gap in information, or missing element is a key element in my definition of the process of creative thinking, it has been given a key role in the methods and materials created by my associates and me for creative development (Cunnington and Torrance, 1965a, b; Myers and Torrance, 1965a, b, c; Torrance, 1965b).

One of Rousseau's (1762) strongest contributions came from his calling attention to the self-acting nature of the learner and the necessity for knowing the natural development of the child. He is famous for such quotations as:

> "We must conquer nature by obeying her."
>
> "Employ the child's activity. Let it learn from things, not books; it is an observer and doer."
>
> "Knowledge comes by the action of our mind, not from what it is told. The real teacher is within."

It was Pestalozzi, Froebel, Montessori, Moreno, and others, however, who developed the educational methods and materials that furthered the concept of guided learning in relation to the self-acting nature of the learner. Pestalozzi (1894)[3] emphasized the concept of intuition. Frobel (Bowen, 1906; Froebel, 1891) developed the doctrine of creativity and frequently used the term "self-activity." Montessori (1964) employed the term "spontaneous activity." Moreno (1946) used the term "spontaneity, and creativity." Their methods of guiding the self-acting learner will be sketched later in this paper.

A number of early American educators, influenced by Pestalozzi and Froebel, criticized the education of their day for failing to recognize the self-active nature of the learner and attempted to bring about suitable educational reforms. One of these, Francis Parker (Mayer, 1964), maintained that the American education of his day (1837-1902) emphasized force and coercion and did not allow students to think for themselves and to ask fundamental questions. Opposing discipline and uniformity, he believed that activity should govern the curriculum. He believed in letting the child move about freely and express his emotion. He believed that a child should be permitted to rebel, if necessary, against his teachers. He permitted children to take part in school administration, used field trips to explore society, and regarded grades as artificial incentives to be avoided. His book, *How to Study Geography* (1899), is a good example of how he worked out his ideas for the teaching of a specific course. He also developed with his teachers a complete curriculum at Quincy, Massachusetts, and later at Chicago.

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[3] Throughout this paper, the citation of references is usually an English translation or a recent and more readily available reprint rather than the original foreign language document.

Harris (Cremin, 1961), an early American educator, believed that the school must lead the child to freedom by leading him away from his primitive self. The end product would be a self-active individual, a reasoning person who can exercise true freedom in terms of his own civilization. He held that it was the business of the school to develop the abilities necessary for a lifelong process of education through self-activity. Hodge, in a 1900 issue of *Pedagogical Seminary*, urged that the maxim of educational reform be the activity of the pupil instead of the didactics of the teacher. He advocated that the active method of the kindergarten and the university be adopted in all grades. In the same article, he complained, however, that entering university students because of their prior educational experiences were not ready for these more active methods. After failing to motivate one student (presumably typical) to formulate a problem for original investigation, he gave him a problem and sent him off to the laboratory, where he found him some days later "reading a very interesting book," having done no experiments nor made any observations.

Guillet, also writing in a 1900 issue of *Pedagogical Seminary*, championed a kind of guided learning that gave an important place to the learner as self-acting. He urged that the teacher "seek out the child's own best possibilities and educate these to the highest degree" (p. 430). He believed that this can best be done by offering the child a varied diet suited to his stage of development, not by attempting a systematic and specialized regimen, because "the child is his own best teacher." He elaborated his concept with the use of the feeding analogy, offering finally the following analogy from nature:

> "If we cage a bird in the act of migrating, it is in vain that we offer him crumbs and berries. He leaves them untouched and beats his wings against the bars of the cage till he be given the free air and sky" (Guillet, 1900, p. 430).

G. Stanley Hall (1905), the famous editor of the *Pedagogical Seminary*, held similar views of the learner as self-acting. He criticized American schools for wasting so much time in training for orderliness in going, standing, and sitting; disapproved of motherly-minded teachers who helped children over difficult times instead of spurring them on to self-activity; and criticized what he called "antediluvian methods, such as learning by heart, and especially the rage for consuming the hours of instruction by hearing recitations" (Hall, 1905, p. 510).

During the next two decades there appeared from time to time in educational journals and textbooks similar pleas for regarding the learner as self-acting and observations that the prevailing education did not give recognition of this aspect of child nature and development. For example, Dumville (1913) wrote: "The child has been considered too much in the light of a passive recipient of information, not sufficiently in that of an active doer" (p. 41). In discussing the problems of "taking children out of their depth" and attempting to teach things too difficult for the child to master, Barnard (1879) maintained that this is not likely to occur, if the learner is regarded as self-acting and the teaching is carried out in accordance with this concept. He wrote: "The child who teaches himself never can go out of his depth" (Barnard, 1879, p. 95).

By 1922, Boraas, another American educator, had become somewhat optimistic about trends in the direction of a more creative education that would respect the self-acting nature of the learner. He pointed out that there had been a time when the surest way for a pupil to land in the "corner" or to be kept after school was to "start something" not in the regular schedule or school routine. He added: "Now 'self-starters' are beginning to be appreciated. Yet, even now, there are timid persons who say that if we let the pupils have the privilege of initiative in school, they will invent many things that will prove worthless" (Boraas, 1922, pp. 14-15). I fear, however, that Boraas would be disappointed, because starting something not in the regular schedule or school routine is still one of the most universally discouraged and punished pupil behaviors, according to answers on our "Ideal Pupil Checklist" obtained from teachers in many places in the United States and in several countries outside the United States (Torrance, 1965b, c).

In France the educational methods devised by Alfred Binet (1909) during the first decade of this century respected the learner as self-acting. On commenting on his Mental Orthopedics, he wrote: ". . . they give a very neat, very clear, very striking example of that new pedagogy which makes the pupil an actor instead of reducing him to being only a listener." He explained that his plans and methods were only illustrative, having been conceived "for children of a certain age, of a certain degree of intellectual development, of a certain culture" and were appropriate for these children alone, insofar as technical detail was concerned. He believed, however, that the principle of the method was generalizable.

Learning by doing was of course one of the themes of the educational ideas of John Dewey (1933), Kilpatrick (1918), and others associated with the Progressive Education Movement in the United States. Their general view of the nature of human intelligence and learning was grounded in active methods of positive inquiry and the systematic subject matters that are the results of inquiry (Champlin and Villemain, 1959). While leaders of progressive education placed emphasis on both the process (creative inquiry) and the product (subject matter curricular content), their opponents accused them of failing to give consideration to the latter, and some of their advocates misunderstood their ideas and placed all of their emphasis on process (the doing).

Moreno (1946) and others point out that there are limits beyond which educational philosophers cannot go, and that others must go beyond their ideas to make them useful. He cites as an example the following statement by Dewey:

> "Since learning is something that the pupil has to do himself and for himself, the initiative lies with the learner. The teacher is a guide and director; he steers the boat, but the energy that propels it must come from those who are learning" (Dewey, 1933, p. 35).

Moreno believes that through action and spontaneity research, he and his associates have been able to elucidate the problem further. He contends that one's involvement in the doing is likely to be so intensive that many experiences and expressions, physical and mental, are unnoticed by the would-be-learner. These unnoticed phenomena, however, may at times be noticed by a co-actor or observer (teacher or fellow learner) taking part in the situation. This means that to give effective guidance, teachers and fellow learners must co-experience or co-act with the learner. The methods of role playing, psychodrama, and sociodrama developed by Moreno and T-group methods developed by the former associates of Kurt Lewin and the National Training Laboratory (Bradford, Gibb, and Benne, 1964; Schein and Bennis, 1965) are examples of methodologies especially designed according to this rationale of the self-acting learner. Other methodologies and the characteristics of the guidance built into them or provided by the teacher will be identified and discussed in the section on methods for guiding learning.

CONTINUITY OF DEVELOPMENT

One of the oldest controversies regarding the nature of human development is concerned with the continuity-discontinuity question. The idea that human development is not and indeed should not be continuous but moves and should move in great beats and surges, dates back to very ancient times and, in my estimation, still is the prevailing notion. For example, a number of eminent psychologists tell me repeatedly that I should not be concerned about understanding and reducing some of the discontinuities commonly found in creative development (Taylor and Williams, 1966).

Both Pestalozzi and Froebel, believing that it is healthy and natural for development to be continuous, worked at ways of developing sequences of activities and kinds of guided experiences that would increase the chances of this continuity. These concerns are clearly manifested in Pestalozzi's *How Gertrude Teaches Her Children* (1894) and Froebel's *Mother's Songs, Games, and Stories* (1891). Both of these books were designed for use by mothers, so that this continuity could be accomplished from infancy onward. As an example, Pestalozzi cautioned that mothers should arrange experiences according to graduated steps of knowledge so that every new idea would be only a small, almost imperceptible addition to earlier knowledge, already deeply impressed and unforgettable. He also advised that the simple should be made perfect before going on to the complex. Froebel thought that his book for mothers should also be known by kindergarten teachers so that they could continue the home-training and not interrupt the child's stages of development. He stressed the point that school should bring new scenes, fresh acquaintances, and a general widening of the child's sphere, but that continuity would "make the child feel at home" and facilitate learning. Thus, he recommended that the finger, arm, and other activities used in guiding learning be continued by kindergarten teachers until they are replaced by other methods of guidance better suited to the child's mental and physical development. Connectedness was a major theme in Froebel's methods. His methods for guiding learning were designed to keep form, language, and number closely connected. The drawings in his book for mothers illustrated his penchant for connectedness. Thus, in one illustration to teach the concept of "wind" he had the weather-cock or vane turning, the leaves and branches of trees blowing, a flag flying in the wind, a kite flying, the hair of the mother and children blowing, clothes blowing on the wash-line, and the like. In addition, the mother was instructed to let the child's tiny hand carry out the movements of the wind and of the things that the wind was moving. Thus, he offered the verse:

> "As the cock, up on the Tower,
> Turns in wind and storm and shower,
> Baby can bend his hand and learn
> To get joy at every turn" (Froebel, 1891, p. 17).

Shirreff, championing Froebel's educational principles in the American journal, *Education*, in 1881, criticized educational systems that "seek to impose a new nature, as it were, upon the child, to cultivate one set of faculties to the neglect of others, to impose knowledge of a certain kind, instead of aiding the newly awakened intelligence to seek the knowledge that is congenial to it" (p. 425). He asserted that "all such systems are false, and whatever they may teach, can never rightly educate."

A number of experiments in American education have from time to time established procedures deliberately designed to reduce the discontinuities in learning. In the Gary, Indiana, system (Burris, 1914), elementary and high school students remained in the same building to emphasize the continuity of education and the heterogenity of the typical social situation. The auditorium was the forum for discussion of common problems. One of the aims of the famous Eight Year Study of the Progressive Education Association (Aikin, 1942) was to redesign the high school curriculum to achieve more continuity of learning.

Alfred Binet (1909) was keenly aware of the discontinuities in education in France and sought to develop instructional procedures that would reduce these discontinuities. He believed that at the time they came to school, children had already developed some powerful skills for learning and that the school should graft education on these already developed skills. In this way, the teacher could benefit from the start already made by nature. He believed that nature would furnish the activity and that teachers need intervene only to guide or direct it. Apparently, Binet did not recognize, as did Pestalozzi and Froebel, that when they enter school children have already been influenced by some type of guidance. He recognized, however, that children enter school with such learning skills as manipulating objects, moving them about, changing them to construct others, questioning, singing, drawing, story telling, and inventing.

Montessori's (1964) methods also emphasized the continuity among both the various aspects of the curriculum and the various aspects of personality. Her methods also recognized the importance of continuity in the sense of not interrupting children absorbed in a learning task to rush them to a different learning task previously scheduled. She wrote: "He who interrupts the children in their occupations in order to make them to learn some predetermined thing; he who makes them cease the study of arithmetic to pass on to that of geography and the like, thinking it is important to direct their culture, confuses the means with the end and destroys the man for a vanity" (p. 180).

Curiosity, the instinct of play, the instinct to manipulate, and the like have been suggested as natural guides to learning. Educational innovators such as Pestalozzi, Froebel, Binet, and Montessori made use of these forces but recognized clearly that curiosity, playfulness, and manipulativeness, unguided, cannot be depended upon to bring about learning. As Barnard pointed out, regarding the modeling instinct: "Education must supply the material and guidance necessary for the development, must convert the aimless touching and fumbling into systematic construction, and direct the instinct into a channel of useful activity . . ." (Barnard, 1879, p. 173).

Both educators and psychiatrists have long recognized that the periods of greatest discontinuity in development are accompanied by sharp increases in mental, emotional, and physical disturbances. While most of the educators and psychiatrists have apparently assumed that those discontinuities are healthy and should be preserved, a small minority has urged that these discontinuities be reduced either by some administrative arrangement, as in the Gary system in the early 1900's, or through some change in the degree and type of guidance offered. The latter point of view is illustrated in the following statement by Bryan, an American educator, in 1900:

> "The hope of fixing hard and fast limits for each of these stages is not entertained; the limits will vary with individuals as everything else does. But it is the hope to show on physiological and psychological grounds that in the development of the child there is a series of periods each more or less homogeneous in itself but widely different from all the others, that each period serves as the propaedeutic to the one that follows and that each is preceded by a relatively short transitional period characterized by mental and physical disturbances which serve at the time for rearrangement and preparation for the stage which is to follow" (Bryan, 1900, p. 359).

In my own studies of the discontinuities in creative development (Torrance, 1962, 1963, 1965d), the cultural or man-made nature of these discontinuities has become apparent. Yet it is also clear that the intervention of the teacher and of instructional materials is so powerful that these discontinuities can be reduced or practically eliminated (Torrance and Gupta, 1964). The issues inherent in the continuity concept are especially relevant to such current issues as the ungraded school, reorganization of the school day into larger blocks of time, team teaching, and the like.

NATURE OF MENTAL ABILITIES

As I examined the educational programs devised by pioneers like Pestalozzi, Froebel, Montessori, and Parker, it has seemed to me that they were handicapped by limited understanding of the nature of mental abilities and their functioning. All of them seemed to recognize intuitively that intelligence is not a unitary function but is made up of many little functions. If the state of knowledge had been such that they could have seen this problem more clearly, their contributions would perhaps have been more powerful than they were. Alfred Binet (1909), however, conceptualized the problem more clearly and used his insights in developing his Mental Orthopedics, even if he failed to do so in the construction of tasks to make up his intelligence scales. He maintained that intelligence is not a single factor, "individual and of a particular essence," but that it consists of the union of all of the little functions of discrimination, observation, retention, and the like. He developed and defended exercises designed to offer practice and guidance in the development of each of the "little functions" that he had identified.

Binet reported in 1909 that chance had suggested a new method which he and his associates sought to extend and perfect through a general plan embracing all of the mental abilities. He recalled the feats of the magician Houdini, wishing that his pupils could learn to perceive quickly a large number of objects at a glance. To do this, Binet showed his pupils large cards on which many objects and many pictures were glued. They were permitted to look at a card for a short period and then, the card hidden, to write from memory all they had seen. The cards were arranged with an ever increasing number of objects. Then he trained the children to respond to questions about what they had seen in the street, in the court, or in class. Then came memory exercises calling for the immediate repetition of words, digits, or sentences, the number being increased each time. Exercises for imagination, ingenuity, analysis, and judgment were also developed. Adults who visited Binet's classes were amazed when they found that his mentally retarded pupils could far surpass them in many memory, as well as productive thinking, activities. Binet maintained that these exercises favored no particular ability and that they facilitated discipline; improved the children's ability to look at the blackboard, to listen, to remember, and to judge; brought into play self-respect, emulation, perseverance, and desire for success; and promoted other generally desirable kinds of growth.

Recent conceptual and psychometric advances pioneered by Guilford (1959), Burkhart (1962), Sigel (1963), Piaget (Piaget, 1950; Flavell, 1963), and others should enable future creators of instructional materials, methods, and plans to be even more successful than men like Pestalozzi, Froebel, Parker, and even Binet. The potentialities inherent in this insight are indeed exciting when we look at recent research, which suggests quite clearly that certain abilities are more highly developed in most children than are other abilities and that accordingly they become the star learners or underachievers, depending upon the route by which learning outcomes are achieved and upon the way in which these outcomes are assessed (Torrance, 1965a). Most of the materials being designed to encourage creative development have made deliberate use of these conceptual and psychometric advances (Cunnington and Torrance, 1965a, b).

Educational thinkers who have contributed to the development of the concept of guided learning have generally held that mental abilities are susceptible to development through educational experiences. Through the years, investigators have presented empirical data to challenge the concept of fixed intelligence. Despite this, the view that intelligence is a capacity fixed once and for all by genetic inheritance is widespread even today. A great deal of empirical evidence has seemed at first glance to support the idea of fixed intelligence. Recently, however, Hunt (1961) proposed alternative explanations and summarized evidence that undermines this idea. Hunt also cited studies that show that out of groups of people tested at some earlier age, those who complete the most schooling show the greatest increases and fewest decreases in IQ. The studies of Spitz (1945, 1946, 1965) have been quite influential in convincing psychologists, psychiatrists, and social caseworkers that intelligence is modifiable, not fixed, and that mothering is crucial during the early years of life. Children deprived of the guidance obtained through social interaction and mothering fail to develop naturally either physically or mentally.

Alfred Binet (1909) condemned quite strongly the prevailing prejudice of his day against the "educability of intelligence." He remarked that the familiar proverb, "When one is stupid, it is for a long time" seemed to be taken literally by teachers. He disapproved of the predominant methods of education of his day, which brought into play almost exclusively the memory abilities and reduced the learner to a condition of passivity. Like many recent observers of classroom behavior, Binet observed in French schools that pupils were rarely called upon to judge anything, reflect upon anything, nor produce anything. They needed only to retain and reproduce. The ideal pupil recited without making a mistake, and the goal of the teacher was to make the pupil's memory function, to see that he knew what was in the textbook, and to see that he could repeat it cleverly at the examination. Binet argued that the result of these deplorable practices for the pupil was a lack of curiosity, a tendency to seek truth solely in the book, an indifference to his environment, a naive belief in the omnipotence of formulas, lack of adaptation to contemporary life, and a routine mind that was "sadly out of place in an epoch when society evolves with infernal speed." Among the goals in developing the child's mind, Binet included the following: to produce and to test ideas on his own, to act spontaneously, to judge for himself, to participate in the life about him, to explain what he sees, to defend his own ideas, to practice making decisions, to learn how to orient himself, to plan his days, to imagine, to invent, to live on his own account, and to feel at once the excellence and the responsibility of free action. Binet believed that the studies in the experimental psychology of his day had demonstrated beyond a doubt that every thought and mental function is susceptible of development. He maintained that every time anyone had taken the trouble to repeat methodically work that had had measureable effects, the results followed a characteristic curve of learning.

In recent years, there have been various studies to determine whether or not the productive thinking abilities are susceptible to improvement through educational experiences. In almost all cases, the results have been positive (Parnes and Meadow, 1959, 1960; Samson, 1965; Torrance, 1964, 1965a, c). Binet's hypotheses, built on the theories of Rousseau, Spencer, and Froebel and the experimental psychology of his day, continue to be supported in our own day, at least as I am able to interpret the data. Apparently the various mental functions, especially those involved in productive thinking, are like skills and thus require opportunity for guided practice in order to develop to any high degree (Bartlett, 1958; Singer, 1964). This seems to be as true of imagination and fantasy as of logical reasoning and judgment.

As our ability to differentiate and assess different kinds of mental functioning has improved, we are beginning to understand some of the puzzling findings of the past in educational research. For example, we need no longer be puzzled by McConnell's finding (1934) that mental age as measured by an intelligence test is more highly related to achievement in second-grade arithmetic when taught by authoritative identification than when taught by the methods of discovery. Hutchinson (1963) in a study involving learning in junior high school social studies also found that, under traditional authoritarian teaching, there is a statistically significant positive correlation between mental age and achievement, but not between measures of divergent thinking and achievement. In experimental conditions offering considerable opportunities for learning in creative ways, the reverse was true. In a study involving fifth-grade children using programmed instruction in language arts, Gotkin and Massa (1963) found significant negative relationships between measures of divergent thinking and achievement. Stolurow (1962) found higher positive correlations between measures of originality and achievement than between mental age and achievement with programmed materials in mathematics and statistics. The difference was that Gotkin and Massa used materials that permitted only tiny mental leaps and gave little opportunity for making, identifying, and correcting errors, while Stolurow's materials emphasize a troubleshooting or hypothesizing approach that builds specific but multiple associations to a stimulus.

MacDonald and Raths (1964) found that children of high creative or divergent thinking ability are more productive on frustrating tasks than are less creative ones. Furthermore, they enjoy such tasks more than their less creative peers do. The least creative children are less productive in open tasks, and the most creative ones react less favorably to closed tasks. Thus, pupils of varying levels of creative or divergent thinking ability react differently to different kinds of curriculum tasks and are possibly best taught by varying procedures.

VARYING DEGREE OF TASK STRUCTURE

Thinkers who have contributed most significantly to the concept of guided learning have emphasized the importance of individual differences in determining the nature and degree of guidance to be given. Present-day investigators such as Goodlad (1965) and Suppes (1964) say that we have only begun to recognize what fantastic differences result when individual differences in ability and style of learning are taken into consideration. Both of these distinguished researchers report that they themselves are constantly amazed by their current investigations and suggest that the staggering implications of individual differences have scarcely been recognized in any school in the country.

Pioneering educational thinkers in America have been especially concerned with the development and recognition of individual differences. Generally, however, these thinkers, including those in the Progressive Education Movement, have been unable to specify the dimensions along which guidance could be varied for individual learners. In practice, rate of learning as predicted by mental age has generally dominated thinking about this problem. Mental age has also been used in estimating the difficulty level of learning tasks to be assigned. Progress in this area has been quite slow. Here and there, short-lived or scattered attempts have been made to classify learners in ways that would serve as guides to the educator in individualizing instruction.

Burnham in 1892, following the model given by Kant in 1780, distinguished between reproductive and productive imagination. He held that individual differences in reproductive imagination are largely qualitative, while those in creative, productive imagination are differences in degree. Thus, in striving for goals in the area of reproductive imagination, a teacher would be concerned about whether to use visual or auditory stimuli or cues. In developing productive or creative imagination, the teacher would be concerned about matters of difficulty, complexity, and the like.

Smith (1924), in his famous treatise, *Education Moves Ahead*, suggested the following classifications as guides for determining the amount of task structure required by individual learners:

1. Those generally able to start and carry on projects or investigations without suggestions from others.
2. Those generally able to carry on alone projects or investigations

started or outlined by others.

3. Those who can help in group projects or investigations. (They may show a higher degree of initiative or originality where they have particular interest or expertness.)
4. Those who show little originality themselves, but appreciate the initiative and originality in others enough to follow their lead or to imitate them.
5. Those who are almost or entirely dependent in their own thinking.

One important variable seems to be the need for structure, as indicated in very gross terms by Smith's hypothetical scale. I have been interested, however, in exploring ways of assessing need for structure and possible effects on the kind of guidance that contributes to improvements in creative functioning. The weekly laboratory experiences in a course in Group Dynamics in Education have afforded me a number of such opportunities. I shall give one example to illustrate some of the kinds of exploratory experimentation that might yield a good pay-off.

On one occasion, my class and I wanted to challenge the generalization from field theory that evaluative feedback is necessary for improvement of group performance. We wondered if this generalization would hold for divergent thinking tasks and if it would hold for all kinds of groups. I had hypothesized that groups composed of individuals having strong needs for structure and control would improve under conditions of evaluative feedback, but that groups having extremely weak needs for structure and strong needs for freedom might actually be blocked in doing a divergent thinking task.

The division of the class (47 graduate students and three undergraduate seniors) into ten five-person groups was based on scores on the Interview Form III of "Runner Studies of Attitude Patterns" (Runner and Runner, 1965). Patterns of *high* resistance to pressure, experimental orientation, and intuitive orientation and *low* social extroversion, practical planfulness, social anxiety, and hostility were used in determining the freedom or lack of need for structure orientation. The five persons having the highest pattern level were placed in Group A, the five persons having the next highest pattern level were placed in Group B, and so on.

The divergent thinking task chosen was adapted from Simpson's (1922) Dot-Square Test of Creative Imagination. Subjects are given several pages, each consisting of groups of four dots in the form of squares. The subject's task is to add two more dots and then to draw objects that use all six dots. Each object is supposed to be different, and subjects are informed that "originality counts for most." The task was administered first as an individual one for warm-up purposes, then as a group task as soon as the ten groups had been assembled, and finally as a second group task following the differential experimental manipulation. Groups A, C, E, G, and I were assigned to the Evaluative Feedback Condition and asked to evaluate their preceding group performance and plan how to improve their group performance in a subsequent test. The remaining groups were assigned to what I have termed Creative Feedback Condition. These groups were instructed to look at one another's responses and enjoy them, noting them so that they could avoid duplicating them and could perhaps "hitchhike" on them for more original ideas. They were further instructed not to evaluate responses or their group performance, but to continue the free-wheeling, hitchhiking idea production that they had started.

All responses were evaluated for originality according to a scoring guide developed by the author. During the first group session, the groups composed of individuals having high freedom orientations (low need for structure) achieved a mean originality score of 63.2 compared with a mean of 32 by the groups composed of individuals having a high need for structure.

The measure derived from the final group session was improvement in originality score. There was a general tendency for the high freedom oriented groups to improve most under the Creative Feedback Condition and for those highest in the need for structure pattern to improve most under the Evaluative Feedback Condition. The performance of the four extreme groups was especially striking. The highest freedom oriented group under Evaluative Feedback Conditions (Group A) gained only 29 points, while the highest freedom oriented group under Creative Feedback Conditions (Group B) gained 115 points. The highest need for structure group under Evaluative Feedback Conditions (Group I) gained 132 points, while the one under Creative Feedback (Group J) gained only eight points.

Using the results obtained from all ten groups, comparisons were made between the upper half and the lower half on freedom orientation. The results are still impressive. Under Evaluative Feedback, the high freedom oriented groups averaged a gain of 79.3 points, and the high need for structure groups averaged 95.5 points. Under Creative Feedback, the high freedom oriented groups averaged 132.5 points, and the high need for structure groups averaged 56.7 points.

If the results of this experiment can be replicated and the principle applied, it should be possible to improve the creative production of all groups rather than applying either treatment to all groups. In spite of the vast individual differences in need for task-structure or guidance, however, it seems apparent that any given learner may be inhibited in attempts to learn either by too great an amount of guidance or too little guidance. A series of classical learning experiments reported by Carr (1930) supports this conclusion. In experiments varying the amount and kind of guidance given children in creative thinking problems, my associates and I (Torrance, 1964) obtained results that support a similar conclusion. Apparently too much guidance is so disruptive or overwhelming that it leaves the learner with no actual guides to behavior and apparently can be as detrimental as lack of guidance, if not more so.

SEQUENCES OF ACTIVITIES

Common to all who have made signal contributions to the development of the concept of guided learning has been the formulation of some scheme for arranging sequences of activities — from easy to difficult, from simple to complex, from concrete to abstract, from top to bottom and vice versa, from beginning to end of a process, and the like. In some schemes, activities have been arranged to conform to some conceptualization or model of the problem-solving process. Some of the schemes offered by the leading thinkers will be summarized here.

Pestalozzi (1894) suggested that learning activities be arranged in sequences in accordance with the laws for the development of the human mind. These laws, as formulated by him, are as follows:

1. Classify observations and complete the simple before proceeding to the complex.
2. Bring all things essentially related to one another to that connection in your mind which they have in nature. Subordinate all unessential things to the essential in your idea.
3. Strengthen and make clear the impressions of important objects by bringing them nearer to you by the art and letting them affect you through the senses.
4. Regard all the effects of natural law as absolutely necessary, and recognize in this necessity the result of her power by which nature unites together the apparently heterogeneous elements of her materials for the achievement of her end.
5. But the richness of its charm (art) and the variety of its free play cause physical necessity, or natural law, to bear the impress of freedom and independence.

According to him, the first instruction should be sounds (spoken, sung, etc.), followed by form, and then by other sense impressions.

Herbart (Broudy, 1963) developed a teaching method that served as a guide for ordering sequences of learning activities. His followers have changed the labels of his steps from (1) clearness, (2) association, (3) systematization, and (4) method to (1) preparation, (2) presentation, (3) association, (4) systematization, and (5) application. The preparation step has two aspects, the motivational and the cognitive.

Froebel's concepts concerning the arrangement of learning tasks into sequences are illustrated in his list of 13 gifts and 11 occupations and the exercises in his book for mothers (Bowen, 1906; Barnard, 1879; Froebel, 1891, 1904).

The gifts were as follows:

1. Six worsted balls, each having one of the colors of the rainbow, with strings attached. The ball was chosen as the first gift because it is the simplest and most complete ground-form. It is the first plaything that a mother gives her child; it is light and soft, can be easily taken hold of, and fascinates because of its tendency to constant motion. Froebel believed that the balls satisfy the child's unconscious need for wholeness — to contemplate, grasp, and possess a whole. He offered a variety of suggestions for guiding learning, using the balls as the object. The balls represent the elements of form, color, motion, and size; and observations and comparisons can be made of these elements. The balls also provide such exercises as grasping, catching, moving on strings to educate the eye in fixing a point, games in the air to excite healthy action of the entire body and awaken grace in all movements, and gymnastics (hopping when the ball hops, etc.). He found that the balls were suitable for children in the nursery up to three years of age and for kindergarten children who have not had experiences with balls. Various games were also suggested for using the ball for learning purposes.
2. Sphere, cylinder, and cube (of wood, hard, smooth, heavy, and resonant).
3. A box containing a cube, subdivided by three cuttings into eight cubes, each one representing the large cube on a smaller scale.
4. A cube divided into eight blocks, each two inches long, one inch wide, and one-half inch high.
5. A cube divided into 27 equal cubes.
6. A cube divided into 27 oblongs of the same size as in the fourth gift.
7. The tables, usually wooden, of two colors and of two shapes.
8. The connected slat, which represents the embodied edge of the whole square, triangle, pentagon, etc. (10 slats each four inches long and one-half inch wide, riveted together at the ends so they can be folded or unfolded to give different forms).
9. The disconnected slat or slat interlacing (wooden slats of varying lengths, widths, and textures, about 10 inches long and 2/5 inches wide, secured in bundles of 10 or 12).
10. Stick laying (representation of the line or edge of a surface).
11. Ring laying (wire rings and half-circles of three different sizes, ranging from one to two inches in diameter).
12. The thread game (a cotton thread in which the ends are joined).

13. The point, the embodied corner of the cube, peas or lentils.

After the gifts came the occupations, as follows:

1. Perforating (pricking). Using a needle mounted in a wooden handle, the child can prick out pictures on white paper mounted over a perforating cushion.
2. Sewing (embroidery) pictures on cardboard.
3. Net-work drawing, drawing books containing ruled pages.
4. Painting (water colors, brushes, and a book containing pictures arranged progressively).
5. Mat-plaiting, weaving, braiding.
6. Paper-interlacing (interwining).
7. Paper folding (square, rectangular, and triangular pieces).
8. Paper-cutting, paper-mounting, and silhouetting.
9. Peas or cork work.
10. Cardboard work.
11. Modeling (modeling wax and molding knife).

Binet (1909) apparently made most of his decisions about arranging activities into sequences according to the difficulty principle, "the greatest principle of pedagogy," in his opinion. He held that it was necessary to proceed from the easy to the difficult and that the transgression of this principle was almost universal and gave rise to the most deplorable errors on the part of even the most intelligent teachers. He believed that a little difficulty is a stimulus to a good pupil, but too great difficulty is overwhelming and has rather serious consequences, resulting in the disorganization of intelligence.

Parker (Cremin, 1961) borrowed quite heavily from Pestalozzi, Froebel, and Herbart and produced a synthesis that is usually regarded as marking a transition from early American transcendentalism to a newer scientific pedagogy and from dependence on European formulations to a more indigenous effort. Parker (Boraas, 1922, p. 165) summarized the sequencing of activities in reflective thinking as follows:

1. Get them to *define* the problem at issue and keep it clearly in mind.
2. Get them to *recall* as many related ideas as possible by encouraging them to analyze the situation and formulate definite hypotheses and to recall general rules or principles that may apply.
3. Get them to *evaluate* carefully each suggestion by encouraging them to maintain an attitude of unbiased, suspended judgment or conclusion, to criticize each suggestion, to be systematic in selecting and rejecting suggestions, and to verify conclusions.
4. Get them to *organize* their material so as to aid in the process of thinking by encouraging them to "take stock" from time to time,

to use methods of tabulation and graphic expression, and to express concisely the tentative conclusions reached from time to time during the inquiry.

It will be noted that this process is quite similar to the creative problem-solving process as formulated by Osborn (1963), Parnes (1962), Guilford (1966), and others. Guilford's model is one of the most elaborate of these models and may prove to be the most useful one thus far offered.

METHODS OF GUIDING LEARNING

In a sense, both the structuring of the learning task and the arrangement of tasks in some sequence, either short-term or long-term, provide some guidance. In this section an effort will be made to identify a few of the additional methods of guidance developed by those who have contributed most heavily to the development of the concept of guided learning. No attempt is made to compile an exhaustive list of methods of guiding learning nor to summarize the evidence concerning the contribution of the ones identified and discussed in this paper. Such an attempt, however, would seem to be of considerable value.

Questions

One of the oldest and most commonly used methods of guiding learning is through the asking of questions. Questioning was central to Socrates' method for guiding learning. He raised questions as one who simply desired to know. Even if the response were in error, Socrates pretended to espouse the ideas and sentiments. Then by adroit questioning, he led the student to develop the opinions and ultimately to recognize from the consequences the extent of his error. This produced a readiness for a positive approach to the development of concepts and the search for the truth.

While it is apparent that most teachers have used questions as a means of testing to find out what pupils know, the use of questions by such educational thinkers as Pestalozzi, Froebel, and Dewey has been for purposes of guiding the learning process. Francis Parker (1899) believed that it was important to "begin where you find the pupil." Obviously one of the quickest ways of finding out "where a pupil is" is usually to ask questions. Parker also believed that pupils generally possess a great many isolated facts which may be brought together and related by judicious questioning. Thus, this type of questioning formed an important part of his method for guiding learning in the teaching of geography. He also used questions to heighten expectations, develop the ability to predict outcomes, produce new ideas, evaluate ideas, and the like.

A number of thinkers have produced lists of questions that can be used to develop skills of convergent and divergent thinking, sometimes as a means of guiding learning following the performance of an exercise and sometimes just in producing ideas. The following is a list of questions offered by Boraas (1922, pp. 160-162) that illustrate the first approach:

1. Review the questions following the first exercise. Which of the conclusions then formulated have been confirmed? What amendments can you suggest to the tentative statements then made?
2. Was the method of "trial and error" equally prominent in your working of each of the puzzles? If not, what explanation can you offer for the difference?
3. Was there any difference in the relative amount of "inner" and "outer" behavior? Do we solve puzzles by the use of our brains only, or do we work them, at least partly, by our hands?
4. As you tried each succeeding puzzle, what use, if any, did you make of previous experiences with puzzles?
5. Did you find any similarities between the puzzles? If so, did they help or hinder you in your work?
6. Which of the puzzles, if any, would you group together so that the same method of attack could be used for each of them?
7. How was your work affected by the different attitudes you took?
8. How was your work affected by having someone watch your progress?
9. How was your work affected by trying to hurry, especially if you were competing with someone else to see who could first get the solution?
10. Did you notice a transfer of training in your work with the different puzzles? Did any of your experiences carry over from one diagram to the other in the first exercise? From the first exercise to the second? If so, did the carry-over help or hinder you?

In the field of creative problem-solving, the following list of idea-spurring questions has been offered by Osborn (1963) for use during the idea-getting phase:

1. Put to other uses? New ways to use it as is? Other uses if modified?
2. Adapt? What else is this like? What other idea does this suggest? Does past offer a parallel? What could I copy? Whom could I emulate?
3. Modify? New twist? Change meaning, color, motion, sound, odor, form, shape? Other changes?
4. Magnify? What to add? More time? Greater frequency? Stronger? Higher? Longer? Thicker? Extra value? Plus ingredients? Duplicate? Multiply? Exaggerate?
5. Minify? What to subtract? Split up? Understate? Miniature? Lower? Shorter? Lighter? Omit? Streamline? Smaller? Condensed?
6. Substitute? Who else instead? What else instead? Other ingredient? Other material? Other process? Other power? Other place? Other approach? Other tone of voice?
7. Rearrange? Interchange components? Other pattern? Other layout? Other sequence? Transpose cause and effect? Change pace? Change schedule?

8. Reverse? Transpose positive and negative? How about opposites? Turn it backwards? Turn it upside down? Reverse roles? Change shoes? Turn tables? Turn other cheek?

9. Combine? How about a blend, an alloy, an assortment, an ensemble? Combine units? Combine purposes? Combine appeals? Combine ideas?

There are many other examples of check lists of questions in the literature. One of the most useful that I know about for teachers is a book by Norris M. Sanders (1966) entitled *Classroom Questions.* This book was developed by Sanders in an attempt to aid teachers in the school system in which he works to master the skills of asking questions that call for more than memory. One of his earlier studies in this school system revealed that over 90 percent of the questions asked by junior high school teachers called only for information in the textbook. This book contains chapters on memory questions, translation questions, interpretation, application, analysis, synthesis, and evaluation questions. In the teacher's guide for *Constructive Behavior* (Torrance, 1965d), I have offered for each chapter a set of questions or problems to illustrate each of Guilford's five mental operations (cognition, memory, convergent thinking, divergent thinking, and evaluation). It is my belief that teachers at all levels of education could almost immediately raise the creative functioning of their pupils and increase their acquisition of knowledge by asking more productive questions.

Responsiveness to Questions

The guidance that results from the way in which the teacher responds to the learner's questions appears to be powerful and has been rather generally recognized as important by those who have contributed to the guided learning concept. Most of them have recognized curiosity as one of the earliest forms of initiative manifested by the child. Although their curiosity and wondering begin before they are able to talk, they begin asking innumerable questions as soon as they are able to talk. I believe it is safe to say that the exponents of guided learning have rather generally respected the questions learners ask but have not attempted to give them final answers. They have recognized the value in playing with questions and in making use of the moment between the question and the answer to guide the learning process. Kilpatrick (Mayer, 1964) stressed more penetrating inquiries rather than trying to give final answers. Wilbur (1865), who espoused the object system of instruction and was influenced by Pestalozzi, had the policy "Never tell a child what he can discover for himself." Parker (1899) believed that curiosity is the strongest intellectual tendency and must be kept alive. He believed that if a child's mind is in a normal (healthy) condition, he is always interrogating nature and his fellows. Even with strong motivation, many teachers find it extremely difficult to be respectful of the questions children ask and to make constructive use of them in guiding learning. To many a teacher, children's questions are seen as highly threatening. I have presented data concerning some of the problems of responding to the learner's questions in *Rewarding Creative Behavior* (Torrance, 1965c).

Use of the Child's Hands

Froebel (Barnard, 1879; Froebel, 1904) placed great emphasis upon the use of the hands as a means of guiding learning. In many of the exercises in his book for mothers, Froebel instructed them to take the hand of the child and guide it in making movements like the thing being examined. He believed that nothing is more contrary to nature than to forbid a young child the use of his hands. Froebel discovered that the use of the hands is the "right method for riveting the child's attention" on what he is learning (connecting all the instruction imparted to it with the use of the hands).

While I have found little deliberate emphasis by other educators upon the use of the hands as a means of guiding learning, either in the literature or in my observations, I discovered somewhat by accident that children who manipulate objects in testing situations produce far more ideas about improvements, unusual uses, and the like than those who do not touch these objects (Torrance, 1963). With some children, each new movement of the hands seemed to stimulate the flow of a new idea. Thus, there may be unexplored possibilities in this means of guidance in teaching for creative growth.

Doctrine of Contrasts, Especially Sounds

Froebel (Bowen, 1906) developed the doctrine of contrasts as one way of guiding learning. He placed hardness with softness, darkness with light, rest with motion, loudness with softness of sound, and the like. He maintained that attention to differences in sound is one of the first awakenings of children. This is one of the reasons why he advocated the use of sound as one of the first approaches to guiding learning in the young child. Singing, rhythmic sounds and movements, and music were thus important guidance tools in Froebel's repertoire. Again, educational literature has given little attention to the use of sound in guiding learning. I have encountered a number of people, however, who have discovered the superiority of singing and other sounds for guiding learning, especially in the various areas of productive thinking. In my own work with four- and five-year-old children, I have discovered that children become more active and imaginative in puppet play if they are encouraged to sing the lines of their puppets and if the leader does the same. I am now exploring and testing some of these possibilities in a new music magazine for six-, seven-, and eight-year olds. The sequence of activities that make up *Sounds and*

Images (Cunnington and Torrance, 1965b) is an attempt to use sounds to guide the production of original images and subsequently creative writing and art work.

Use of Objects

As already evident throughout this paper, many of the educational thinkers who have contributed to the guided learning concept centered a great deal of their guidance around the examination and exploration of objects. In the United States there was a great deal of discussion concerning what was termed "object teaching" (Wilbur, 1865; Calkins, 1880). One of the advantages claimed for the object method of teaching is that it causes the child to examine for himself, discriminate for himself, and express for himself, while the teacher "stands to give hints and suggestions, not to relieve the labor" (Calkins, 1880, p. 170). (I would assume that what occurred here might be labeled convergent thinking.) In my own work in the development of tests of creative thinking and the creation of classroom activities to foster creative growth, the usefulness of objects seems quite clear.

Analogies

Closely akin to object teaching is teaching by the use of powerful analogies. The writings of almost all of the educational thinkers discussed in this paper are filled with powerful analogies that can be adapted to a wide range of age, educational level, interest, and the like. This is especially true of Froebel's work. Here and there in their writings is a recognition that analogies can be used to guide thinking, to elaborate ideas, and to continue to stimulate ideas, helping the learner to see things in a different way and in greater depth. Thus far, I have been unable to find in any of the early work the thorough and systematic analysis of the role of analogies, as is found in the recent work of W. J. J. Gordon (1961) and those associated with him in "Synectics" as an approach to the development of creative capacity. From the analysis of electronic recordings, observations, and other data, it became apparent that the moments of discovery, new insight, and idea breakthroughs occur in groups when certain psychological states occur. They soon learned, however, that it was difficult or impossible to operationalize these psychological states so that groups could be taught to develop them. They found that they could teach groups to play with analogies and that in doing this, the requisite psychological states occurred. They also found that when they could translate an analogy into a model, this model developed an autonomy of its own that continued to guide their thinking. Analogies may also be used as guidance in organizing hitherto unorganized data.

Drawing Attention to Child's Own Experiences

Although almost all of the educational thinkers discussed in this paper guided learning by drawing attention to the individual's own experiences, Froebel (Bowen, 1906) perhaps deals with this type of guidance more systematically than any of the others. He gave quite specific suggestions to mothers about ways of doing this. It was a part of his way of reducing the discontinuities in learning and of producing further learning. He selected materials that were interesting and as closely related to the child's experiences as possible. From a very early age, he accustomed the child to consecutive action. He believed that the child must continue to draw from his memory bank—"The child must ever and anon recall his own little past, connect it with the present, and when occasion offers, reach forward from them both, though but a span's length, into the future" (Bowen, 1906, p. 84). One of the problems in laying the conditions for creative thinking is to help individuals bring into consciousness more of their experiences so that they can draw freely upon them as a source of ideas.

Self-Evaluation

Another powerful technique of guidance that runs throughout the ideas of educational thinkers like Socrates, Plato, Pestalozzi, Froebel, and Rousseau is self-evaluation. Froebel placed a great deal of emphasis upon the encouragement of the "impulse to self-culture and self-instruction through self-shaping, self-observation, and self-testing (Froebel, 1904, p. 16). One specific approach is illustrated by the set of questions proposed by Boraas in the section above on questions. Boraas (1922, p. 46) himself believed that it should be the teacher's constant aim to develop in learners the ability to question their own judgment, to judge the value of their own work, and the like. Most of the deliberate methods of creative problem-solving now being taught include periods of suspended or deferred judgment during the idea-getting stage. Later, however, criteria for evaluating the ideas are developed and applied in reaching decisions.

Organization of Physical Environment

With her medical background, Montessori (1914, 1964) was perhaps more sensitive than other educational thinkers to the possibilities of guiding learning through the organization of the physical environment. She was aware of the physical problems caused by schools, such as myopia, spinal curvature, anemia, liver complaints, and the like, and took special measures to create conditions that would prevent these. Her real contribution to the use of the organization of the physical environment to guided learning, however, sprang from her idea that a child left at liberty to choose his activities "ought to find in his surroundings something organized in direct relation to his internal organization which is developing itself by natural laws, just as a free insect finds in the form and qualities of flowers a direct correspondence between form and sustenance" (Montessori, 1964, p. 70). She was aware, however, that an overabundance of material is confusing and retards progress.

In laying conditions for creative development, the tolerance of disorganization and complexity and the ability to reorganize disorganized elements into a new order seem to be important (Barron, 1963). Montessori, too, recognized both the need and the capacity of the young child to organize things in his environment. Stress theory, however, would lead us to agree with Montessori regarding the overabundance of materials and the excessiveness of disorder (Torrance, 1965d). Both are likely to act like stressors, with an increase in the amount of available materials and disorder increasing level of mental functioning up to a point after which there would be what she describes as "debilitation and retardation of growth." There are times when creative growth is facilitated by reducing stress (assuming an attitude of playfulness, fun, and the like), but at other times it is necessary to increase stress and call into action more expensive energies and higher levels of mental functioning. In guiding development, the teacher must be sensitive and alert to the stresses operating on the learner in order to make use of the organization of the physical environment (as well as degree of difficulty, degree of structure, and other elements used in the guidance process), whether one is concerned about the acquisition of information or creative functioning.

Other Ways of Guiding Learning

It is perhaps not now possible to catalogue all of the ways of guiding learning. In closing this section, however, it seems necessary to mention specifically such things as these: giving purpose and meaning to learning experiences; developing aim and commitment among learners; providing appropriate and provocative models and examples; and rewarding in various ways the kinds of development desired (including examinations and grading procedures). In addition there are various kinds of feedback, diagnoses, or analyses of difficulties; experimentation and testing of hypotheses; use of games, toys, and miniatures of life situations; personal contact; and the use of chalkboards and other visual devices for focusing attention and concentration. Developing a taxonomy of methods of guiding learning should perhaps be a high priority in developing a theory of guided learning.

An Example of Guided Learning in Teaching for Creative Development

I shall now describe briefly an example from my own work of an attempt to develop and evaluate through field tests a set of materials making use of the concept of guided learning to teach for creative development. The reader will be able to see in this description applications of most of the ideas identified in the preceding section of this paper and will perhaps be able to identify additional ones.

My interest in exploring the possibilities of guided experiences in creative thinking grew out of relatively unsuccessful attempts to help teachers learn to encourage creative development in children. In field experiments and in-service education workshops, my assistants and I tried in various ways to assist elementary teachers to apply insights from research in developing the creative thinking abilities. The most generous interpretation of the results would credit us with only moderate success.

Following these experiences, it occurred to us that we might accomplish more by developing materials applying the idea of guided experiences in creative thinking. These guided experiences would represent an attempt to avoid some of the apparently inhibiting attitudes, lack of spontaneity, lack of time, and perhaps lack of boldness or courage among many elementary teachers. We believed that through workbooks, laboratory manuals, and recordings accompanied by teacher guides we could reinforce the spontaneity, courage, and boldness which the teacher needs in order to direct creative ways of learning. R. E. Myers led the way in developing several sets of exercises which were later combined into workbooks or idea books with teacher guides (Myers and Torrance, 1965a, b, c). Cunnington then initiated the idea of constructing tape-recorded materials that bolster the teacher's spontaneity and ability to grip the imagination of children. In creating all of these materials, we tried to build in the best of what we know about the creative process, the creative person, and the conditions favorable to creative behavior (Cunnington and Torrance, 1965a).

Development of Instructional Materials

We decided to develop the recordings and associated materials for use in the fourth grade, since children at this grade level commonly show decrements rather than gains in measured creative thinking abilities and participate in fewer creative activities than children in the third grade (Torrance, 1962). It was our goal to construct these materials so that they would be used in the best tradition of planned, guided educational experiences, making use of our knowledge of the learning task and the nature and function of the learner. It was also our aim to motivate pupils to participate in the guided sequence of experiences by making the recorded dramas and exercises interesting, exciting, and rewarding.

An analysis of the learning task suggested that emphasis be given to the following five major objects:

1. To discover, motivate, and develop creative awareness.

2. To develop an understanding of the nature and value of creative thinking and creative achievement.
3. To provide provocative data in the form of dramatized materials in the fields of science, history, geography, and the language arts.
4. To stimulate and guide creative behavior.
5. To create an awareness of the value of one's own ideas.

We desired to correlate the bulk of the materials with the usual curriculum of the fourth grade. Thus, it was established that one-fourth of the material would deal with great moments of scientific discovery and invention; one-fourth, with great moments in historical achievement; one-fourth, with great moments in geographical discovery; and one-fourth, with fantasy related largely to the language arts. In spite of this division, however, it was intended that any single planned sequence of experiences might take the learner into several curricular fields. For example, one of the records in the "Great Moments in Scientific Discovery" series might lead directly to art and creative writing experiences. These in turn might lead to activities in reading, history, music, arithmetic, character education, psychology, economics, government, and various areas of science.

The dramas are designed to grip the interest of children and to familiarize them with the nature and value of the creative process, the creative person, and creative achievement. These dramas may be stopped at strategic points for problem-solving, guessing of consequences, and consideration of various possibilities. Usually, however, these procedures occur after the playing of the dramatized episodes and are subsequently followed by discussions, inquiries, and creative activities. The teacher guides offer many alternatives and challenge teachers to produce their own ideas to achieve goals stated in the manuals or the specific goals of the class. On a subsequent day, a related experience is presented by means of the recordings. This experience may involve an experiment, creative writing, art, dramatics, song writing, creative problem-solving, inventing, or any of a number of other creative activities.

For example, the dramatized episodes of the life of Louis Braille emphasize the idea that a child's ideas may be valuable and that great discoveries and inventions occur through courage and persistence, building onto the ideas and failures of others. One of the lessons accompanying this story leads children to make an inventory of the things that bother them and to select their most bothersome "thorn in the flesh." They are asked to find out what other attempts have been made to solve this problem and to build onto it.

Realistic problems may be related even to fantasies. For example, the dramatization based on the Italian legend of Giovanni and the Giant gives rise to a variety of such opportunities. Each time Giovanni finds himself in a threatening predicament, the record is stopped to permit the listeners to produce possible solutions to the predicament. By the time the story is finished, each student has produced enough ideas for a new version of the Giovanni and the Giant story. On the following day, however, the story may be used to encourage a very different kind of thinking. In the original story Giovanni uses deception. In the related exercise, students are asked to develop some of the skills of penetrating deceptions. In one version, common everyday swindles and hoaxes may be dramatized, and the listeners may be asked to penetrate the deception. In another version, some of the historically famous hoaxes may be used. These may be related to the geography or history being studied at the particular time.

All of these materials make deliberate use of the principle of warm-up and draw from research on training for originality. One of the best examples of this is our *Sounds and Images* (Cunnington and Torrance, 1965b), which uses a series of four sound effects presented three times. With each repetition, students are asked to stretch their imagination further and further. The first sound effect is easily recognized, coherent, and well-organized. Succeeding sound effects increase in strangeness and lack of obvious relationships among the sound elements. The fourth sound effect involves six rather strange and unrelated sound elements, placing quite a burden upon the ability to synthesize unrelated elements into a coherent whole.

Guiding Insights from Research

On the basis of the accumulated research concerning the creative thinking process, I prepared the following list of guides (with elaboration) that all personnel in the project attempted deliberately to translate into the form of dramas, exercises, suggested activities, and teacher guides (Torrance and Gupta, 1964):

1. Value creative thinking.
2. Help pupils become more sensitive and open to the environment.
3. Encourage guessing, predicting, experimenting, and manipulating.
4. Teach how to test systematically each idea or possible solution.
5. Beware of forcing a set pattern.
6. Develop a creative classroom atmosphere, free from undue threat, rejection, and fear of making a mistake.
7. Develop tolerance and consideration of new or divergent ideas.
8. Teach pupils to value their own ideas.
9. Teach skills for avoiding unnecessary punishment and rejection.
10. Give information about the nature of the creative process and the value of creative achievement.
11. Dispel the sense of awe of masterpieces.
12. Encourage and give credit for self-initiated learning.
13. Develop "thorns in the flesh" (cognitive dissonance).
14. Create necessities for creative thinking.

15. Provide for active and quiet periods.
16. Make available resources for working out ideas.
17. Encourage the habit of working out the implications of ideas.
18. Develop habits of constructive criticism and creative problem-solving methods.
19. Encourage acquisition of knowledge in other fields.
20. Be an adventurous-spirited teacher, seeking, searching, and inquiring.

General Description of the Materials

Each of the recordings revolves about the role of creative problem-solving, the importance of courage and other personality characteristics necessary for creative achievement, and the contribution of guided experiences in creative behavior. An effort is made to give the pupil intimate insights into the thought processes which enabled courageous men like Edison, Franklin, and the Wright brothers to make important creative contributions.

Much care was exercised to document the science, history, and geography recordings with fidelity to historical fact. As much as possible, primary sources were used as the basis for the materials created.

Consistent efforts were made to tailor the materials to the level of fourth-grade pupils without "talking down" to them. Vocabulary level and sentence structure were supervised closely by consultants with considerable experience in teaching fourth-grade classes. In some cases, however, the consultants were skeptical about the adequacy of the vocabularies of fourth-grade pupils, and pilot tests were made. In many instances, children had no difficulty with words which the consultants thought were "over their heads." In most cases, these were technical terms that have come into common use during the lives of the pupils.

Field Tests and Evaluation

The recorded, planned instruction was carried out by 15 fourth-grade teachers in one school system and by three in each of two other systems. Control groups were drawn from similar fourth-grade classes in the same schools. A battery of tests of creative thinking, tests of general educational development, the How I Like School Inventory, and Creative Activities Checklists were administered to both the experimental and the control classes prior to and after the experimental program. The growth of the subjects exposed to the experimental materials was compared with that of subjects in the control group through use of appropriate statistical tests of significance.

In the school system involving 15 experimental and 15 control teachers, the control subjects showed losses rather than gains on four of the 10 measures of creative thinking, while the experimentals showed gains on all 10 (eight statistically significant). In the second system (three controls and three experimentals), both controls and experimentals showed statistically significant gains, but the experimentals showed superior growth on three variables and the controls on one, when posttest scores were corrected for pretest scores. In the third system (three experimentals and two controls), the experimentals showed gains on all 10 variables, while the controls showed losses on two of them. Thus, in spite of the fact that the control teachers did many things to encourage creative growth, the evidence is in favor of the experimental classes.

In all three school systems, a smaller proportion of the experimentals than the controls indicated that they "hated school." During the Christmas vacation, the experimentals reported having engaged in a larger number of creative activities on their own in two of the school systems. During the summer vacation, the experimentals in one system reported a larger number of creative activities than their controls. In all other cases the differences were not statistically significant.

In one school system the use of the materials seems to have facilitated traditional kinds of educational achievement. In the second it seems to have made no difference. In the third it may have interfered slightly with arithmetic achievement but made no difference in other areas.

Thus, the weight of the evidence seems to indicate that guided experiences in creative thinking can facilitate creative growth at the fourth-grade level and tends not to interfere with usual kinds of achievement.

The reaction reports of the teachers indicated that most of them improved gradually in their ability to use the recordings effectively. Some of them achieved outstanding success almost from the beginning. Some were resistant to using the recordings throughout, and it is clear that a few of them did little more than play them to their classes. In almost all classes the recorded dramas seemed to grip the imagination of the pupils. Response seems to have been especially good among boys, gifted boys and girls, and children who tend to be isolated and non-conforming. Response to the recorded lessons was also generally enthusiastic except in cases where the pupils had not been prepared in advance for the activity and where motivation conditions were generally rather poor. A number of teachers indicated that some pupils who were not ordinarily motivated became enthusiastic about some of the activities.

Follow-up studies to determine the durability of some of the effects found immediately after the completion of the experimental program would have been desirable. Such studies were not possible. However, two years later, arrangements were made to administer to two of the experimental and two of the control classes in one school an instrument designed to assess concepts concerning creative problem-solving and self-concepts concerning oneself as a problem solver. Forty-eight of the experimentals and 56 of the controls were available for testing at this time. During the fifth and sixth grades, these groups had been distributed rather randomly in four different classes. The school does not practice homogeneous grouping and has a generally rather strong emphasis on creative development.

It was found that, when compared with the controls at the end of the sixth grade, the experimentals more frequently tended (a) to reject the idea that every problem has only one right or best answer, (b) to be concerned about thinking of new ideas rather than finding fault with ideas, (c) to have respect for the possible usefulness of "silly" ideas, and (d) to see the possibility of getting ideas for successful solutions from incorrect ones, and the like. The experimentals were also comparatively more hopeful about their own ability to find solutions to problems, more willing to work on difficult problems, and more hopeful about their ability to continue to develop and improve their ability to think and solve problems.

CONCLUSION

An examination of some of the great educational ideas of the past reveals many possible contributions to the development of a theory of guided learning. Most of these ideas have had inherent in them the self-acting and creative nature of the learner. Thus, these ideas are a rich source for generating new ideas concerning materials, methods, and conditions for fostering creative development. Initial and halting attempts to translate some of these ideas into experimental materials and guidance for teachers seem promising on the basis of initial field tests and evaluations.

PANEL DISCUSSION

DR. DAVIS *presiding:* As you know, many psychologists are more concerned with how learning takes place than they are with guiding that learning. One of the things that distinguishes the psychologists presenting papers at this conference from their colleagues is the fact that they are more concerned with how to guide learning in a classroom situation. We hope that your questions will draw the speakers out on this important subject. We will hear from the chairmen of the discussion groups in turn.

DR. LAYCOCK, *chairman of Group I:* Parents, teachers, and even pupils feel confined by the demands of the present school situation. How do we "free them up" so that they will be able to accept the guided learning approach?

DR. TORRANCE: Although this question would be difficult to answer, I think we know enough to at least alleviate the situation. For example, I teach in a large university which requires that grades be made in A, B, C and turned in 48 hours after the examination. These requirements make it impossible to evaluate creative application, problem solving, and that sort of thing. The development of these abilities is not likely to occur in this kind of situation if you evaluate a student's production from the beginning. One of my policies is not to count in the final grade anything that the students do during the first half of the course. I react to their exercises, censure them for their mistakes, and give them plenty of guidance. This policy gives the students time to make mistakes, learn how to correct them, get some reading under the belt, and do some thinking. I have found that this procedure encourages students to think about what they are learning and to apply it. Typically, these students do not come with the expectation that what they learn will be useful in problem solving. They need some experiences to help them change their expectations.

Froebel and Parker and all the others had difficulty in getting their ideas accepted. How do we profit from them and avoid some of the mistakes that have been made? Recent research about the strategies and methods of innovation offers some hope. We should work on the problem of developing an attitude of acceptance of new ideas in workshops, in interaction with the community, and in teaching students and supervisors. But it is a complicated and difficult problem.

DR. GROSSLIGHT, *chairman of Group II:* A series of questions arose as to the relationship of guided and programmed learning: Is the teacher a necessary intermediary in guided learning? Is programmed learning really a representation of the lowest level of guided learning? Is there a difference between programmed and guided learning in the nature of the reinforcer i.e., does programmed learning include only the knowledge of results as the reinforcer, whereas guided learning makes use of a variety of reinforcers? Is the reinforcing method of learning just as *laissez-faire* as the discovery method?

DR. TORRANCE: The comments I make will be in terms of my feelings, my experiences, and the results of my research concerning these problems as they relate to creative development and learning the skills of creative thinking. About the necessity of the teacher, my best guess is that the teacher is not always necessary; but certainly in our present culture, for most children, in most situations, for most purposes, the teacher is important in making learning effective.

I have considerable sympathy for some of the arguments about teaching various kinds of things to certain types of children, particularly disturbed children and children from low socio-economic status who live in poverty and who may have an offensive odor. Notice that the machine does not act negatively to the way these children smell or to the condition of their clothes—as the teacher may—so the children find in the teaching machine a greater acceptance than they do in teachers. In this kind of situation the teaching machine may be more effective in human relationships than the real live teacher is.

A co-learner or a teacher may be very necessary, however. So much may be happening that the learner can't see his resistance to learning, to change, etc. — but others can. Sometimes the individual is able to accept direction from a co-learner more readily than he can from a teacher who is in an authority position.

Certainly in guided learning, where things are arranged according to a sequence, there is some degree of reinforcement. My own concept of guided learning includes a variety of methods of guidance (or reinforcers) and can be applied to a variety of problem-solving processes. Guided learning may even be used when it is the *process* that is learned.

In answer to the last question, "Is the kind of guidance that takes place in guided learning as *laissez-faire* as the kind that takes place in the so-called discovery learning?", personally, I don't think so. I think there is a fundamental difference: the person who accepts and practices the *laissez-faire* over-estimates the receptivity of the mind. We have a great deal of experimentation to show that individuals do not necessarily learn automatically from their experiences and that some guidance and some direction are necessary. If an individual doesn't have some guidance and direction, there is danger of emotional disturbance, of giving up, of failing to keep going. Man has to have some anchors in reality; he has to have some guides to behavior in order to behave effectively. This is the kind of thing that Binet made such a to-do about. He felt that many of the mentally retarded children he was working with were the victims of a kind of education that gave no guidance. They worked at jobs that the teachers knew in advance were too difficult for them. The teachers said, "You will learn from these jobs, even though you don't succeed." Instead, the children became confused and apathetic and finally gave up. Binet said that instead of growing mentally they deteriorated. From my understanding of the psychology of stress and mental health, I conclude that man has to have some guide to behavior in order to use his intelligence to solve problems.

DR. MCNERNEY, *chairman of Group III:* Our group was concerned that, at this conference, we develop some ideas which will help the classroom teacher. We ought to define our terms so that everyone will know what guided learning really is. Also, what is the difference between creative thinking and the response to a stimulus?

DR. TORRANCE: The idea that theory is inapplicable to practice has been very damaging to the recognition of educational theory and research and has handicapped practitioners in the field. There is an inescapable relationship between theory and practice. Teachers in the classroom are the people who can construct educational material and develop devices and they should also construct the theory. As soon as we get rid of this superstition of the dichotomy between theory and practice, we will begin making some progress in educational practice and research, in the development of materials, etc. I think that my own life and my own teaching are a manifestation of an effort to translate theory into practice and to develop theory through practice. I do not think that this conference will be a dialogue between psychologists and psychologists. It is, in fact, a dialogue between educators and educators.

On the matter of common terminology — words do have different meanings for different people. If I were to ask you to respond to the words we have been using in terms of black and white and red and blue, I would get varying emotional responses. Words have different meanings to you at a depth level, depending on your past experiences in relation to those words and concepts. Even though we defined our terms with the same words, they would still mean different things to different people. Let's not allow this to be a handicap. These words have been in the vocabulary for centuries and centuries, and there is no reason why we should change them.

People have told me that my definition of "creative thinking" is not compatible with its historical use. My contention is that it is compatible. Go back at least to Kant's *Critique of Pure Reason*, where he made the kinds of differentiations that I am talking about. I think there is possibly some difference in the use of the words "producing a response" and "creating a response," because many of the responses that we produce are learned responses, whereas the others are responses that we have never thought of before or never produced before. I have tried to come to grips with the problem of definition in my article in the summer issue of *Daedalus*, the journal of the American Academy of Arts and Sciences.

I don't think this is the place and time to get into an argument about the difference between creativity and producing a response. My own interpretation would be that one can produce a varying kind of response — an overlearned one or a response that has never been produced before. This is one of the reasons we try to differentiate between the convergence response — the learned response — and the divergent response — the one which has not been learned but is produced by some kind of recombination or rearrangement.

DR. FLEMING, *chairman of Group IV:* Are these learning strategies applicable to all groups of children and particularly to the child with lower levels of ability?

DR. TORRANCE: This is a very interesting phenomenon. I think you should look at the literature throughout history where ability grouping has been used, based on some index of intelligence, mental age, or something of the kind. In general the differentiations have been made in the *speed* with which things have been learned. Of course one of the things we find when we group people according to any ability is that, even though we might have homogeneity on that variable, we have very great heterogeneity on other variables. I think that the other variables may be more important in the kinds of differentiations we make.

For example, in the group experiment I discussed in my paper, I arranged people in 10 groups from top to bottom on a personality variable which might roughly be called a "freedom orientation" or an orientation to rules and structure. Then every other group was placed so the people had individual performance and then group performance without any guidance. Then came the differentiation of treatment. Alternate groups were given evaluative feedback. The other groups were given what I call the creative feedback, i.e., they were not to do any evaluation at all, but were just to look at and enjoy one another's responses and ideas and "hitchhike" on those. We found that those groups that were high in freedom orientation without a need for structure made very little improvement under evaluative feedback, whereas those in the creative feedback made tremendous gains. The opposite was true of the groups that were in the lower half, those who tended in the direction of the need for structure or a ruled, planned orientation. They made practically no improvement under the creative feedback, whereas they made enormous improvement under the evaluative kind. The differences were statistically significant and quite clear-cut.

I think this kind of experimentation can be sensibly transferred to practical situations within classes as well as between classes. We get considerable support for this thinking from the research. For example, look at McConnell's study in 1934 comparing discovery learning with identification learning. He found that there was a higher correlation between mental age and achievement under learning by identification than there was under learning by discovery. McConnell was very disappointed in this result, because he was a believer in the Gestalt psychology of learning by discovery. The materials had been very carefully developed by him and included a great deal of guidance to bring about this kind of discovery. It was by no means a *laissez-faire* kind of thing. He took the upper fourth and the lower fourth for comparisons. No matter how he manipulated the data, he found that he still got higher correlation between mental age and learning under positive identification than under learning by discovery.

In the last two or three years we have had several experiments in which children have been given the traditional kinds of intelligence tests, like Stanford-Binet and Otis, and tests of divergent thinking, from which measures of originality were obtained. We found the same phenomenon taking place under the traditional authoritative kind of orientation, i.e., higher correlation between intelligence and learning than between measures of originality or divergent thinking and learning. If these children are taught in situations where they have an opportunity to engage in a variety of kinds of mental operations — divergent thinking, convergent thinking, productive thinking — then you find that the reverse is true. We are not changing the criteria; we are only changing the way the criteria are reached. Then if we change the way things are evaluated, we really get something different.

DR. SCHREIBER, *chairman of Group V:* We have three questions: How it is possible to accept techniques of guided learning without first defining more carefully the various abilities which children need in order to make use of such techniques and the individual differences which are important to measure and consider in designing guided learning programs? Secondly, are guided learning techniques useful in very large classes? Third, why do children of older ages in higher grades seem to do less creative thinking and more rote memory types of work than do children in the lower grades?

DR. TORRANCE: These are very complex questions that deserve complex answers. All I can give now are over-simplified, rather extreme positions on these. Certainly in order to intelligently develop guided learning programs one does need more than a single index of an individual's ability. In addition to knowledge about abilities and the different kinds of factors that Binet mentioned a great deal, we need to know something about children's preferences, their styles of learning, etc. The more we know about these the more nearly possible it is for us to do an intelligent job. I think this is what Suppes (1964) and Goodlad (1965) and others had in mind when they said that we haven't even dreamed of the possibilities for improving learning through individualization. We know enough *now* to do a lot better than we do in guided learning. I hope that we will continue to make progress and will have sense enough to use what we know.

How do we introduce more guided experiences in larger classes? I would hope that we would do the reverse of what we did some 20 or so years ago. Then we had experimentation and research concerning small classes. In general the experimentation showed that people taught small classes just as they had always taught large classes — by the lecture method, by demonstration, or something of the kind that did not involve the learner. Now that we have larger classes, I hope we will explore more ways of engaging large groups in producing responses and giving them feedback about their responses.

The most successful large-group experience I have ever had was at the University of California a couple of years ago. I had 200 students for three hours a day for two weeks. I gave them guided, sequential kinds of learning and activities that involved them in learning on the spot from their own experiences. I was pleased with the results. Judging from the product, I think my students achieved a higher level of creative functioning than had been produced in any other class. I have adapted the experiment and used it in groups of 50 to 100 that I characteristically teach during a regular term at the University of Minnesota. It almost breaks my back, and evaluating the products almost kills me when I am forced to give a grade under this kind of system, but it is feasible. Good teaching will always require expensive energies from the teachers. Engaging each individual as a self-acting learner requires the most sensitive kind of guidance and direction to keep the students working toward a worthwhile goal.

We need to know a lot more than we do about the kinds of differences between old people and young people. I have observed that under certain conditions older people can become as creative as younger ones. I take issue sometimes with our admissions authorities at the University of Minnesota about their prejudices in admitting some of the older students to graduate school. There may be a reason in some fields, but not in education. The main run of our teachers are so vulnerable to the criticisms of the community and the prejudices of those who evaluate them that they do not have enough courage to do the most effective job in helping children to learn. Since the status of older teachers is not so vulnerable, they can bring about some revolutions. In my classes I had two women past 65 who have probably done more to change education in Minnesota than all the rest of my students put together. They had the courage to advocate changes that have proved by experience to be successful.

You are curious about the fact that children show creativity in the lower grades, and this diminishes as they grow older. The common notion here is a gross over-simplification that has a great deal of error in it. We do find this in terms of the measures we use for divergent thinking. Awareness of problems, for example, seems to be an important element in creative thinking. But however you want to define creative thinking abilities, as we are now able to measure them in our culture they generally show a decline at about the fourth grade. If you look back you find these reasons: the ways teachers are trained, the kind of discipline, the children's activities, and the books children read.

After the decline at the fourth grade, creativity shows a series of gains and dwindlings. Another peak of creativity is found at about the sixth grade, followed by a drop around the seventh grade, a recovery, and then a dwindling or a gain at the eleventh or the twelfth grade, depending upon the kind of teaching in the school. The kind of material I used for the study, "Development and Evaluation of Recorded Programmed Experiences and Creative Thinking in the Fourth Grade," is powerful enough to bring about changes in most situations. Other studies support this research.

When we look at creative development in other cultures, we find the drop taking place at different ages or not occurring at all. These cultures are almost always characterized by very continuous development in other abilities and few discontinuities in growth. In our culture a child almost from birth has rather strong sanctions against exploration, questioning, and other childlike activities that would naturally lead to the development of creativity.

These phenomena are complex, but I emphasize that there is a great deal of error in the statement that older people lose their creativity. Some people continue to be extremely creative even beyond 80. Edison made a huge number of inventions after he passed 70. We have many other people who continue to be extremely productive, but, of course, this isn't the norm. Most of the great ideas come from young men who later become so overwhelmed by the pressure of administrative jobs, etc., that they do not have time to play with ideas, develop them, and improve them.

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CHAPTER III

Review of Recent Studies Involving Guided Learning

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Until relatively recently, learning studies based on Piaget's theory of cognitive development have been conspicuous by their absence. This has been interpreted by some to suggest that Piaget's is very largely a maturational theory of cognitive development, with learning assigned a relatively minor role in the development of the cognitive operations.

Although Piaget denies that his is a maturation theory in the classical sense of that word, he had until recently done little to provide empirical evidence indicating how the forms he describes become a part of the child's cognitive life.

Piaget has, of course, been criticized for this lack of learning experiments, and beginning in the late 1950's a number of research studies done both by Piaget and his co-workers and by other investigators began to appear in the literature. It is the purpose of the present paper to review these studies and to critique them in terms of the topic of the present conference.

The typical pattern followed in this research is to set up groups of subjects which are matched insofar as their development of some form of thought is concerned (e.g., *S*s who fail to conserve number). One of these groups of *S*s is then used as a control group, and one or more groups are given training in the form of thought used to set up the groups. A posttest is then given to compare the performance of the training group or groups with the no-training control group.

The early studies dealt almost exclusively with the areas of number and quantity. Two studies by Churchill (1958) were among the first and, although the training procedures were very general (informal practice in grouping, seriating, and ordering), her experimental group did show a considerably greater gain than the control group in the performance on a test of Piagetian number tasks.

A somewhat more carefully controlled study was done by Wohlwill and Lowe (1962). Specifically, Wohlwill and Lowe were interested in determining what effect various types of training would have on conservation of number (invariance of number under changes in length or configuration of a collection). The subjects were 72 kindergarten children. All *S*s were given a pretest which consisted of a series of questions to establish *S*'s ability to deal with number concepts such as counting, equivalence (*S* had to lay out as many chips as *E* had laid out), and number vs. length (*E* laid out rows of six and seven chips and asked which was longer). *S* was also given a verbal and a nonverbal conservation pretest. Three training conditions were then set up: a reinforced practice condition, a dissociation of biasing cues conditions, and an addition and subtraction condition. Posttesting showed little change for any group in verbal conservation. There was a change in nonverbal conservation, but the control group showed as much change as the other three groups.

In a later study, Wallach and Sprott (1964) investigated the effect of showing children who did not show conservation of number, that the number had indeed remained the same. This was done by manipulating the number and position of dolls and beds. The *S*s used were 30 first graders who had shown nonconservation on a pretest. Two posttests were given, one immediately after the training session and one 14 to 23 days later. The difference between experimental and control *S*s was highly significant in both posttests, with little difference between performance on the first posttest and the second one.

An experiment on a related problem is that of Feigenbaum and Sulkin (1964) dealing with the effect of training on the conservation of discontinuous quantities. In the pretest the *S*s were given 14 beads and two glasses and were asked to put seven beads in each glass. *S* was then asked if there were equal numbers of beads in the two glasses. *E* then poured the beads from one of the glasses into a taller, thinner glass, and *S* was again asked if the number of beads was the same in both glasses. Those *S*s who conserved the quantity were eliminated from the experiment. The training provided was of two types: a) reduction of irrelevant stimuli and b) reinforcement by addition and subtraction. After the training, *S*s were given a posttest. There was a gain from pre- to posttest, and it was greater for group A than for group B.

The effect of training on conservation of weight has been investigated in a series of experiments by Smedslund (1961a, 1961b, 1963b). In general, the results have been somewhat equivocal. One interesting innovation in the research of Smedslund was an attempt to determine the effect of examples of apparent nonconservation on the responses of children who had acquired conservation "normally" and those who had acquired it by means of practice using balances. All 11 *S*s who had acquired conservation using the balance reverted to nonconservation thinking, while only seven of 13 in the "normal" group did.

Smedslund (1963b) has also reported a study of the effect of practice on transitivity of weight ($A>B, B>C : A>C$). Here, as in the other studies, the results are somewhat equivocal.

In another experiment Smedslund investigated the effect of training on the child's representation of spatial orientation of a water surface (1963a). The *S*s were 27 children from age five to seven. They were shown a bottle half-filled with water and asked to note the position of the water. They were then shown six pictures of bottles in various positions and asked to draw the water surface for each. After this pretest the *S*s were shown a bottle half-filled with ink-water, which was rotated in steps of 30° to a full 360°. After having seen this demonstration, the *S*s were again asked to draw the water surfaces in the six pictures of bottles that had been used in the pretest. The results indicated some improvement in performance for *S*s who had given some correct responses in the pretest. The *S*s who had given no correct responses on the pretest derived little benefit from the demonstration.

Robinson (1964) reports an experiment on the effect of training on the size-weight illusion. (When objects are of equal weight but different sizes, the smaller is perceived as being heavier when lifted.) Thirty children from ages two to three were divided into two groups, with one group of 15 trained to discriminate pairs which differed in weight by as little as 30 grams. On a posttest the trained *S*s did much better than the control *S*s, and the finer the discrimination the child could make in training, the less the size-weight illusion.

Beilen and Franklin (1962) studied the effect of training on logical operations in area and length measurement and found that first and third graders showed a gain over and above the training effect of taking the test.

A superficial glance at the results of some of these studies might lead to the conclusion that training does not have an appreciable effect on the development of the mental operation involved. This could in turn lead to the suggestion that the only thing to do is wait until "nature takes its course" and not make any special effort to hurry the development of these operations. There is, however, another possible explanation for the results, and that is that the experiments do not involve the proper kind of training. The training rather typically consists of having the *S* work with and verify solutions to problems similar to those used in the pre- and posttests. There is typically a minimum of explanation provided the *S* during his training trials; i.e., it is left pretty much up to him to "discover" the principle operating in the situation. The situation is somewhat analogous to that which arises in the discovery method in problem-solving. Although the discovery method may have certain advantages, it also has some rather severe limitations. A not unbiased, but very pointed discussion of these limitations is given in an article by Ausubel in the Bulletin of the National Association of Secondary School Principals (1961).

One alternative to the discovery method is to arrange the situation very carefully and provide the learner with numerous verbal and situational cues which guide his learning, not just so he can solve the present problem, but also to assure his learning the principle operating. There is little reason to suppose that principles learned in this fashion are any less useful in the future than are those learned through discovery.

If such a "guided discovery" method were to be used in teaching a child conservation of weight, the training period would not just involve giving him practice in comparing the weight of a piece of clay when it is a "ball" and when it is formed into a "pancake", but a conscious effort would be made to teach the principle that "weight is not affected by shape." One of the most powerful instructional tools available to the teacher is language, and not infrequently more might be accomplished by "telling them" than by "letting them find out for themselves."

Four recent studies in which this type of guided learning was employed have been reported. The first of these (Ojemann and Pritchett, 1963) involved an attempt to develop the concept of specific gravity in kindergarten and first-grade children. Two classes (an experimental and a control class) were used at each grade level. The experiences provided the *S*s in the experimental classroom were presented in such a fashion as to enable the students to see that "weight of object" and "weight of equivalent body of water" are critical in determining what will and what will not float. The training consisted of three one-hour periods. During the first period the general nature of the problem was discussed, and several incorrect solutions to "why something floats" were explored and discarded. At the beginning of the third session the possibility that the weight of the water "pushed away" might have something to do with the problem was presented, discussed, and demonstrated. The results indicated rather clearly that the experimental group did indeed learn the principle of specific gravity, and comparison with the control group suggested the gain shown was not just a function of taking the tests.

A second study by Ojemann, Maxey, and Snider (1965) followed the same general procedures as that by Ojemann and Pritchett, but involved the teaching of probability concepts rather than specific gravity. The *S*s were 41 third graders, 20 in the experimental group and 21 in the control group. The first training session consisted of a general discussion of everyday situations where "best guesses" must be made and of general illustrations of probability situations. This first 30-minute session was followed by four others on succeeding days. At each of these sessions probability situations were presented and discussed. Posttesting showed highly significant differences between the experimental and control groups on their responses in situations which involved probability.

The other two recent studies (Kohnstamm, 1963 and 1965) will be discussed elsewhere in the proceedings and will not be presented here.

What these four studies suggest is that the cognitive processes in Piaget's theory may well be a good deal more amenable to training than has been assumed possible up to the present time. The results are certainly suggestive enough to warrant continuation of such research.

GENERAL DISCUSSION

Mr. Willford: Have any research studies used the co-twin technique in order to differentiate maturational and learned effects in regard to these tasks? Do you think this technique would be useful for equating maturational differences in studies comparing two types of training?

Dr. Schoer: The co-twin method presents many problems, and this particular area of research has been investigated very little. As educators, we cannot do much about maturation and intelligence, but we do know that environment has an influence and can be altered. Perhaps it would be more profitable to investigate those factors which have an influence on bringing a child through these stages, rather than seeing whether it's a matter of maturation or training. However, I would agree that the method would be all right for comparing training programs.

Dr. Kohnstamm: I would like to add that if you do a good job of selecting a control group, it's really not necessary to use a method such as the co-twin method.

Mr. Cunningham: I thought you implied a condemnation of the discovery method as somehow evil and far inferior to "telling the child." Yet, there seems to be a fair amount of "discovery" in your explanation of guided learning. What is your definition of discovery — *laissez-faire?*

Dr. Schoer: As defined in the research literature on problem-solving, discovery method is almost the same as *laissez-faire*.

Mr. Cunningham: I think that is a dangerous definition.

Mr. Willford: How do you view Gagne's work as related to guided learning? Have you found any credence in or support for using his hierarchy of learning?

Dr. Schoer: I think the kind of guidance discussed by Gagne and a number of other investigators in this area will fit. That is why I believe programmed learning may be seen as applicable to guided learning. Programmed learning can be very similar to the two guided learning studies I discussed (Ojemann, Maxey, and Snider, 1965, and Ojemann and Pritchett, 1963), the difference being the presence of a teacher. The kind of structuring Gagne discusses could be used for developing programmed materials which approximate guided learning programs. The advantage of the programming approach is the number of students whom you can reach.

Mr. Willford: As you described Dr. Ojemann's study, I envisioned the children progressively going up the hierarchy of Gagne's taxonomy to the problem-solving level. Have you looked at this hierarchy for possible guidelines for guided learning?

Dr. Schoer: Gagne doesn't take a very generous view of theory as such; however, his work might be especially pertinent for two of the characteristics of guided learning, analyzing the nature of the learner and analyzing the nature of the learning product. These analyses are often overlooked in research. Too often in our teaching we operate at a level in Gagne's hierarchy which is considerably above the level on which the students are operating.

For those of you who are not familiar with Gagne's hierachy, I will explain. Gagne sets up eight levels of learning, including such types as conditioning, sequencing, what amounts essentially to instrumental conditioning, chaining, and the like. These types are arranged in a hierarchy and a certain degree of learning at the lower levels is necessary before the learner can operate at higher levels. Frequently we erroneously assume that the learner has what he needs from the lower levels. For example, the learning program that was set up in the study on probability made certain assumptions about words the students knew. The definitions were assumed to be on one level; then an attempt was made to teach the students to apply these definitions at a higher level.

Dr. Ojemann, did the children in your groups have any choice about whether they participated in the experiment?

Dr. Ojemann, No. Students accepted this as part of the class work. The rapport between the students and the experimenter was very good. We have evidence from several sources that children accepted this as part of their science lesson; and, quite the contrary, I don't think they would have liked to be left out.

Dr. Gilchrist: The conference is focused on "guided learning." Could it just as well have been called "directed learning?"

Dr. Schoer: Whether you use the term "guided learning" or "directed learning" depends upon whether the direction or guidance comes before, after, or during the time the student is responding.

Dr. Ojemann: We toyed with the idea of using the word "planned." But in our culture the words "planned" and "directed" have a dictatorial connotation. "Guided" comes nearer to what we wanted to describe.

Dr. Schoer: In the literature the term "directed discovery" has been used in problem-solving. The term "guided learning" comes very close to what we are talking about here and to what many of you think of when you hear the term "discovery method." This is not the "muddling" kind of discovery in which the child is left to himself.

Dr. Gilchrist: I was hoping this conference would develop (1) more clarification of the role of the youngster's own goals or purposes for learning and (2) suggestions as to the kind of instruction in which the youngster would participate more actively than he has traditionally.

Dr. Schoer: Do you mean participating in the sense of setting objectives or participating in the sense of seeing meaning in what is going on? We should consider both in formulating definitions and a theory of guided learning.

Dr. Kohnstamm: You said guided learning studies could be found somewhere on a continuum between method studies and reinforcement studies. You reviewed some Piagetian studies and some cognitive studies. Why are these studies more relevant to guided learning than are the reinforcement studies or research which compares methods of teaching?

Dr. Schoer: They may all be relevant, but the point I wanted to make was that studies in which comparisons are made between two methods of teaching typically involve such a large number of factors that it becomes almost impossible to identify which factors account for the change. Thus, these studies have not added much to knowledge which is useful in formulating a guided learning theory.

Dr. Kohnstamm: That is an argument from a psychological viewpoint, not an argument from a pedagogical or didactic approach to guided learning. I don't believe their exclusion is warranted.

Dr. Schoer: The nature of the problem pertinent to guided learning theory tends to lie between methods studies and reinforcement studies. I am not suggesting that there aren't factors in each that might be relevant. And certainly, guided learning theory ought to be relevant in later research on methods of teaching.

Dr. Kohnstamm: You also said that programmed learning could be relevant for guided learning. As far as I know, programmed learning is based upon the reinforcement theory. What kind of programmed learning can you think of as being guided learning?

Dr. Schoer: Programmed learning is now a long way from reinforcement theory. However, programmed materials may be guided learning programs; yet the research on which they are based may represent an entirely different approach to learning.

Dr. Kohnstamm: We need to attend to this question: "What made the study a guided learning study?"

Dr. Ojemann: Your question is also pertinent to the definition of terms. In a sense, an investigator may be "guiding" the learning of a child when he gives him an external reward. We may have to use an adjective before "guided learning" to differentiate between that kind of guidance and the guidance in which you make an analysis of the nature of the learner and the nature of the learning product and then build a sequence from where the learner is, to the learning goal.

Also Skinner did not do very much as far as analyzing the nature of the learner is concerned. He did not consider the learner's feeling of the significance of what he was studying, for example.

Dr. Schoer: I think we had better make a distinction between research and the application of that research. There isn't any question that a number of the factors that could conceivably affect guided learning are factors that have been extensively researched. These findings need to be considered in constructing guided learning sequences that are tested experimentally. The latter may be called guided learning experiments, whereas the former may or may not, depending on the procedures used in setting up the experiment.

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CHAPTER IV

Experiments on Teaching Piagetian Thought Operations

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Guided learning needs, among other things, a theory of cognitive development. As Piaget's theory is at the moment very much *en vogue* in Anglo-Saxon countries, the question of whether his theory can serve this purpose arises. You will have realized from my preceding papers that I think this impossible for several reasons. Most of these reasons I cannot prove with "hard" facts, but they must be evident to anyone reading Piaget's books with a critical and educationally-oriented mind.

I shall begin by mentioning these reasons. Then I shall discuss some general characteristics of Piaget's relevant learning experiments. The analysis of these characteristics will provide many issues relevant to experimental work on guided learning in general.

One of the underlying reasons that Piaget's theory is inapplicable to guided learning is that Piaget never really has been interested in education, although the name of his institute may have made many think so. This name "Institut des Sciences de l'Education" is misleading and redolent of the many misleading cues Piaget has introduced in his experiments for young children.

Piaget's "school" is not interested in education either. When I was in Geneva in May 1965, several of Piaget's co-workers told me that "only Pierre Greco is interested in education." Professor Aebli of West-Berlin wrote me: "It seems to me that the Genevans don't want to see the possible learning processes since their starting point is Rousseau's conception of development, in which education and learning occupy a very moderate position." Now, Aebli was a "brilliant" schoolteacher himself (Piaget's own qualification) and seriously tried to make Piaget's theory fruitful for school education. This can be read in a book by him published in 1951 (see Aebli, 1951).

In spite of the fact that he is not really interested in education, Piaget now and then creates the impression that his theory is relevant to it. For instance, Eleanor Duckworth begins her paper, "Piaget Rediscovered," by writing: "Everybody in education realizes that Piaget is saying something that is relevant to the teaching of children." And a little later she writes: "Contrary to the view most often attributed to him, he (Piaget) maintains that good pedagogy *can* have an effect on this (intellectual) development" (see *Piaget Rediscovered*, 1964, p. 1).

What does Piaget consider good pedagogy? To understand this we might just mention, without going into details, the fact that in Piaget's theory *action* plays the first violin and *language* the second (the conductor being a tendency of the mind to strive towards equilibrium).

Although his early books have been criticized for their "verbalism," Piaget has come way back from his initial accentuation of language. Today "verbal thinking" seems to him marginal to real thinking, which, even though verbalized, remains until about 11 to 12 years of age, and is centered upon action (see Laurendeau and Pinard, 1963). I quote from the very significant remarks Piaget made while at the Cornell Conference (1964, p. 5).

> "Words are probably no short-cut to a better understanding... The level of understanding seems to modify the language that is used, rather than vice versa... Mainly, language serves to translate what is already understood; or else language may even present a danger if it is used to introduce an idea which is not yet accessible."

Language being a necessary evil, the truly pedagogic adult should keep his mouth shut, except for asking the child diagnostic questions. It seems as if there is a Piagetian rule which says: As soon as the adult starts speaking the child stops his active handling and operational thinking and becomes a passive machine, waiting for atomistic S-R connections to be stamped in. Instead, the child should be active himself, handling his material environment as much as possible, discovering by induction the laws governing the physical world and by deduction the laws of logic and mathematics. The child should be allowed free play, and the good pedagogue should provide him with the playthings.

At the Cornell Conference Piaget said: "The teacher must provide the instruments which the children can use to decide things by themselves. Children themselves must verify, experimentally in physics, deductively in mathematics. A ready-made truth is only a half-truth." And also: "A teacher would do better not to correct a child's schemas, but to provide situations so he will correct them himself" (see *Piaget Rediscovered*, 1964, p. 5).

And what are we to make of Piaget's respect for pedagogics when reading the next statement made at the same conference? "The best idea I have heard from a pedagogue at the International Bureau of Education in Geneva was made by a Canadian. He said that in his province they had just decided every class should have two classrooms — one where the teacher is, and one where the teacher isn't" (see *Piaget Rediscovered*, 1964, p. 5).

If that is the best thing a pedagogue can tell Piaget, it seems very strange to me that the educators present at those conferences did not protest in their papers against Piaget's view regarding their role in developing the child's mind.

Let me make it clear that I consider Piaget's theory beautiful and his life-long work a masterpiece — especially his theory with regard to children up to about two years of age, which gives, I think, a good explanation of cognitive growth. But to say that his theory can serve as a frame of reference when educating the minds of children of school age is quite a different matter.

Another thing which I must be clear about is that my purpose is *not* the acceleration of what in Piaget's theory develops "spontaneously." Although it might seem so from my experimental work in trying to teach "preoperational" five-year-olds an insight characteristic of the operational level, it is not my intention to hasten the intellectual development of children living in culturally rich environments. The thing I want to demonstrate with these experiments is that there are ways of helping a child to solve new problems which are sound from a pedagogical and yet impossible from a Piagetian point of view. By demonstrating a possible acceleration I intend to show that the theory is *wrong* — — not that we could strive towards this acceleration. Before continuing I must stress one final thing: I am not an opponent of free play and of the various activities the child may wish to fill his days with, even in school. I am not an advocate of teacher-centered didactics, the child listening with folded arms. I not only enjoyed Montessori schools from the age of four to 18, but I also love my own children most when they are amusing *themselves;* exploring their environment when very young and constructing their own play-world when a little older.

Of course spontaneous acting upon their environment is very good for children; it may stimulate growth the way Piaget describes that. But this does not have to imply a minor role for the immense stimulating force of language! Why can we not have it both ways — activity *and* language, inextricably mingled?

In fact, more people are doing research on the interrelation between language and cognitive development than on the interrelation between activity and cognitive development: Two examples of groups who are conducting this type of research are the Russians, although with a deplorable accent upon verbal conditioning, and the Center for Cognitive Studies at Harvard. From these investigations one day an educationally useful psychology of cognitive development may be expected.

Why did Piaget find it necessary to discard the role of language? What is wrong with an adult helping a child with words and guiding his actions to behave in a new way? If an adult helps a child to overcome his perceptual centerings upon wrong cues by teaching him to use mediational tools like new strategic combinations of words and actions, and teaches him to *use* these new tools (not only to recite them rote-fashion, as Piaget's school interprets any form of verbal learning), why should that necessarily imply the learning of a "half-truth," a "quasi-notion," or a "pseudo-concept"? Is it because it is not based upon action? Why not? Can not the adult with the help of words teach the child to act himself? The distinction between "language" and "actions" is as artificial as Piaget's closely related distinction between learning and development (see Cronbach in *Piaget Rediscovered*, 1964).

We now turn to a short review of the general characteristics of learning experiments expressly designed to accelerate the acquisition of Piagetian operations. The general opinion about these learning experiments is that they have had "remarkably little success in producing cognitive change" (see Flavell, 1963; see also Huttenlocher, 1965). However true that may be, I do not believe this to be caused mainly by the way thinking develops in the minds of the subjects — as described and explained in Piaget's theory — but above all by the nature of the chosen didactics.

Let us begin with the end, the quality of the acquired learning results. The newly acquired behavior patterns should be tested for their quality. When the experiments are done with preoperational subjects in order to see if they can reach an operational behavior pattern in a certain field, this quality should be "operational" in the Genevan sense of the word, at least as far as the Piagetian demands for quality seem reasonable. But what is reasonable?

Piaget himself has often discussed these criteria, and most recently at the Cornell Conference. There he said that the acquired behavior should be 1) lasting, 2) transferable, and 3) fundamentally different from the pre-experimental level of behavior. As to the first criterion, which we shall name *durability*, Piaget's opinion is that "if a structure develops spontaneously, once it has reached a state of equilibrium, it is lasting; it will continue throughout the child's entire life." Since a research worker can not wait that long for durability testing, usually periods of between one week and half a year are used. Piaget said in Cornell: "What remains two weeks or a month later?" It goes without saying that in his eyes, the longer the period between training and the last posttest, the better for the qualification of the acquired behavior.

Although I have used this criterion myself, I do not think it to be a very important one. Why is it necessary for the child to remember without further training or repetition? The learned behavior usually bears no relation to daily life, so the child will very seldom *use* the newly acquired "operation." In Piaget's theory the postulated underlying structure develops *because* of the need for the child to use it in daily practice. The fact that he is able at some time to solve the Piagetian problems in a so-called "clinical" experiment proves that the underlying structure has been developed.

But what if this postulation of a gradual developing system of underlying structures were false? And what if the child one day solves the problem because in fact: 1) He has learned in daily life to use language to such a level as to be helpful in handling misleading perceptual cues. (See Wohlwill, Cornell Conference, 1964.) 2) He structures his thought at the very moment of being confronted with the necessity of doing so (Aebli, 1963)? If these explanations were truer than Piaget's, remembering without further reinforcement would be a less important criterion for the quality of the acquired behavior. Therefore, the criterion of durability presupposes that Piaget's theory is true. This makes it a doubtful criterion when testing the theory.[1]

The second criterion of *transfer* or *generalization* is a widely accepted criterion for the quality of a learning result. Here too: the more the better. But exactly how much transfer is needed in a Piagetian quality test? The answer can only be either theoretical and vague or empirical, based upon examples of Genevan experimental practice.

The Piagetian theoretical answer is heavily loaded with the presupposition of the truth of Piaget's theory about the organization of the mind in *structures d' ensemble*. If, for instance, Bovet and Pascual-Leone (1966) try to refute my experimental results (Kohnstamm, 1963) by saying that I did not prove that the subjects, after having learned behavior *a* were automatically able to perform a behavior *b*, *c* and *d*, all related to the same underlying structure S, they presuppose that this structure S actually exists and is really responsible for the existence of a so-called "grouping of operations." Greco (1959) noticed this to be a presupposition and as a result has not used a theoretically derived transfer test in checking the quality of his experimental results.

The same presupposition underlies the view that a good check on the operational character of a learned action of conservation (of weight for instance) is testing the subjects for transitivity, because conservation and transitivity are closely knit together, at least in Piaget's theory (Smedslund, 1961). But apart from Piaget's theory one can of course apply transfer tests on the grounds of the general idea that an acquired notion has more insight-quality if it can be transferred to new problems. For example, Greco (1959) studied the possibility of teaching children the inversion of the order of three elements *a b c* into *c b a*, when the tube in which these elements were fixed (upon a rod) was rotated 180°, and the inversion of the original inversion (*a b c* again) after two rotations of 180°. He checked the quality of the acquired notion by testing for correct solutions in:

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[1] Let us note in passing that this postulation of Piaget's theory causes concepts like "remembering," "forgetting," "brushing up one's memory," etc., to play no role of importance in his books nor in his many experiments. Either the child has developed a structure or he has not yet done so. If he has, he possesses it for his entire life. Could a theory which neglects the many problems of memory be of much value for education?

a) 3, 4 and 5 rotations (the same apparatus)
b) the inversion of order of elements fixed
upon a rotation disk (different apparatus).

Greco invented these tests because they seem reasonable, not because they necessarily follow from Piaget's theory of groupings of operations.

With all Piaget relevant learning experiments it has been difficult to invent reasonable transfer tests without leaning too much on as yet unproven assumptions of underlying unity. The reason seems to be that many Piagetian tasks are so bound up with a very specific material situation. In experiments using verbal materials or verbal concepts which can be applied in many pictorial or imaginative situations, the problem is easier to solve. Kreezer and Dallenbach, for instance, (1929) had no difficulty in finding really new items for transfer after they had taught their subjects to use the relation of opposition. The same applies to the experiments we did on teaching children to name similarities and differences between two verbally presented stimuli, as is done in the Stanford-Binet Intelligence test (Kohnstamm, 1965).

Anyway, a transfer may be "near" or "far." To give an example: in Beilin's experiment (in press) children were taught conservation of length and number. Beilin considered a "far" test of transfer the generalization to conservation of area, and a "near" test of transfer the generalization to a series of length and number items which differed only in color from the learning items. A transfer may be too near or too far to be significant. If it it is too far it is an unreasonable test of the quality of the learned concept or operation. As far as I know nobody has criticized Kreezer and Dallenbach for not having checked if their subjects were able to solve immediately and without further training problems of naming the whole when only a part was given, although the chances are good that in a hypothetical Piagetian theory on verbal thinking the part-whole relation and the relation of opposition would be members of one "grouping" with an identical underlying structure.

There are other problems relating to the criterion of generality. One is the question of whether it is necessary for a child to be able to solve the transfer test immediately and without any help at all, or if he may be helped a little. In my opinion the idea of no help at all presupposes the existence of the above mentioned underlying wholes. In practice most experimenters allow some trials for the child to become accustomed to the situation. But how far may one go putting the child on the right track and directing his attention to the analogy with the problems taught?

I will not linger over the criterion of the *difference* between pretest and posttest behavior, because this difference is implicit in the above-mentioned difference between training and transfer (the child is being trained to change his pretest behavior into a qualitatively different posttest behavior).

In Piaget's publications another criterion is often mentioned, that of *necessity*. If the child feels that the newly acquired response must be right because it follows necessarily from the premises, a Piagetian will be satisfied. The trouble with this criterion is that one must place a lot of trust in what the child says after being asked why he gave the (correct) answer. Together with all other kinds of *verbal explanations* the child may give, this criterion is reminiscent of the time that Piaget was criticized for taking the child too much at his words. It is my opinion, though, that additional use may be made of the child's verbal explanations in testing the quality of his acquired notions. For instance, the way Smedslund (1961) categorized the explanations of his subjects into symbolic, symbolic-logical, perceptual and ambiguous seems useful. If one takes the precaution of testing for interjudge reliability, verbal explanations may serve as a good criterion.

Gestalt psychologists have attached much weight to the *suddenness* of the breakthrough of insight as against the gradual rise in number of correct answers in a process of conditioning. Greco used this argument in demonstrating that what his subjects learned was no simple S-R connection, as did Morf (1959), although in a less detailed manner, and Kohnstamm (1963, 1965).

In Gestalt theory insight always came spontaneously and was originally limited to sudden mental restructurings in the perceived situation. The concept comes close to "discovery," and, as with the latter, the question may arise as to whether insights should be acquired spontaneously or if one may be helped with them. It is my opinion that any teacher who can demonstrate a distinct moment of qualitative change for the better in his pupil's responses has the right to suppose that insight has occurred as a consequence of his didactics. The criterion seems very useful, too, as an argument in discussions about Piaget relevant learning studies, although Anglo-Saxon research workers have not made much use of it as yet.

The same is true for a criterion which has been used only intuitively as yet: the *ease* of the learning process. It is important to know how much energy a child (and the experimenter) expends in reaching a certain level of behavior. An easy victory is suspected to be of less value than a difficult one! I have the impression that I did not make clear in my article on the teaching of inclusion problems that some children had great difficulty in learning to solve the problems. With them, it was very hard work for both experimenter and child. Perhaps if my Genevan critics, Magali Bovet and Pascual-Leone, had themselves experienced this situation of real struggle, with the adult guiding the child, they would not have thought the children passive, "reading with ease the ready-made solutions from the facilitated situations" (1966). But I myself experience this same impression (lack of significance because the training requires so little energy) from other Piaget relevant learning studies, e.g., the study by Wohlwill and Lowe (1962), in which the subjects were not confronted with any real problem and consequently developed no solutions.

There is another important group of criteria which may be named *resistance*. If a child has learned to behave in a new way characteristic of a higher level of development, the depth of understanding can be tested by trying to lead him astray. Smedslund's (1961) "resistance to extinction" belongs to this group, as well as the resistance to a verbal counter-suggestion as used by Wallach and Sprott (1964).

Counter-suggestions are very typical of Piaget's way of testing children, and one of the main arguments Bovet and Pascual-Leone (1966) have against my experimental results is that I did not try to confuse my subjects after having taught them to resist the misleading perceptual cues so characteristic of all Piagetian situations. In future research I shall also use this criterion, albeit not without also having first taught my subjects, in a different task, that their teacher (*E*) may sometimes try to mislead them. Only after having accustomed a young child to the idea that this stranger (*E*) sometimes systematically tries to mislead him does a resistance-test seems a good criterion of the quality of understanding. Otherwise, the timid child may fall back on the old anwers, which E deftly suggests to be correct, while the self-confident child may resist. Variables of personality or child-adult interaction should not interfere with the testing for quality of cognitive growth.

Of the above mentioned criteria, *durability*, *generality*, *verbal explanations* (including *necessity*), *suddenness* of transition from incorrect to correct answers in the learning process, *ease* and *resistance*, suddenness and ease are criteria which cannot systematically be introduced in a post-test. They are properties of the learning process. The other criteria are properties of the acquired learning result. As such they may be subsumed under a last and encompassing criterion, that of *comparing* the behavior of the young learners with the "spontaneous" behavior of a control group of older children. In the Piaget relevant learning studies only Greco has used this criterion in a systematic way. A problem is, however, how much older the older children should be. Although this criterion is a very important one, we shall not linger over it here.

Still other criteria are conceivable but have not as yet been used in Piaget relevant learning studies. In fact, I am thinking of a very nice new criterion, but I shall have to do some research before knowing for sure if it is really a good one.

Now we turn to the different learning methods as used in Piaget relevant learning studies. Most Piagetian problems seem to resist being solved by simply reinforcing the correct answers of the subjects (Smedslund, 1961; Wohlwill and Lowe, 1962; Beilin, in press). Periods of free play with the materials seem equally insufficient to bring about in a relatively short time the necessary understandings (Greco, 1959; Morf, 1959).

Attempting to overcome these barriers, other experimenters have tried to give different kinds of aid — from material hints to verbal rule instruction. To start with the latter, simply telling the child the verbal rule leading to the correct solution, seemed relatively successful in one experiment (Beilin, in press) but not in another (Greco, 1959). It is the kind of verbalism Piaget is most opposed to because it is so isolated from action. Beilin told the subjects of one of his experimental groups each time they gave a wrong answer, "Whenever we start with a length like this one (*E* points) and we don't add any stick but only move it, it stays the same length, even though it looks different. See, I can put them back the way they were, so they haven't really changed." This rule was given upon each incorrect answer in two training sessions, lasting about 40 minutes each, and consisting of 36 similar items of conservation of length.

From a methodological point of view it is understandable that the experimenter always repeated the rule in the same form. From an educational point of view, however, it would be more interesting to be less rigid with the verbal composition of the rule, and to adapt it to the special needs of the child and the moment in the learning process.

Still other investigators tried to make their subject construct the right solution by bringing them into a state of cognitive conflict. Smedslund (1961), referring to the theories of Festinger and Berlyne, created situations which might induce cognitive conflict in the subject but which would not provide him with any feedback as to whether his judgments were right or wrong.

This procedure of studying several possible learning factors *separately* is typical for most of the Piaget relevant learning studies. Each experimental group being treated with only one method at the same time, the investigators hope to discover which factors are responsible for cognitive growth. For reasons of experimental elegance these experimenters avoid using different kinds of aid at the same time as much as possible. Understandable as this may be from a methodological point of view, it prevents us from concluding that, since teaching thought operations to preoperational children has had rather limited success, this teaching is useless.

In our own experiments, in which our purpose was *not* to test several possible factors *apart* but to reach an operational learning result *by* *any means*, the teaching was pretty successful. Our learning method was a very flexible combination of training sub-operations (e.g. counting and comparing counted numbers), confronting the child with his own contradictions, making him use verbal rules to resist the misleading perceptual cues inherent in the problems, making his solution more stable and flexible by helping him through many different settings of the same problem, while at the same time discussing matters verbally with him and giving positive and negative reinforcements at that. Although sloppy from a methodological point of view, when we adapted strategies to the special needs of the individual child and repeated items when necessary, our five-year-olds learned to behave in a way definitely better than five-year-olds should behave according to Piagetian standards.

We started by explaining to the children how to solve the problems in their easiest form and increased the complexity of the problems only after they had shown signs of understanding with the easy ones. This is a very common didactic principle which, strangely enough, has not been applied by other experimenters in the field. Bovet and Pascual-Leone (1966) write in their critical article that "facilitating" procedures, like beginning with the easiest form of a problem, may easily lead to quasi-insights because it allows for a less operational solution of the problem. This is a typical example of how alien Piaget's school is to educational practice. In fact, these authors are of the opinion that if facilitating factors have been introduced in the learning process, the learning result is *ipso facto* devoid of a truly "operational" character.

It appears to be very difficult for many experimental psychologists to think of the possibility of making the child a very active problem solver by guiding him verbally and motivating him with "external" reinforcements and "internal" conflicts at the same time. Trained as a psychologist myself, I remember the strange feeling of guilt when I started guiding my subjects in solving the problems they could not solve spontaneously; it was against the rules of diagnostic testing and experimentation, which prescribe a strictly neutral attitude for the psychologist and only allow some examples to be given.

One could object that our learning method is neither objective nor standardized, and therefore bad from the methodological point of view. It certainly is, but the method works and eventually could help in bridging the gap between psychology of cognitive development and education.

Of course the experimenter should assume the typical neutral attitude while in the posttest sessions. Here he should strictly avoid guiding the child, just as the teacher in school does during exams. An exception could be made for the first examples of a new kind of problem introduced to test for the generality of the learned operations.

My Genevan critics have rightfully pointed out the fact that I have tested only for transfer within different *materials*, including purely verbally posed problems, and that I should have changed the problem itself, because it might be conceivable that familiar problems (belonging to the same Piagetian family of a *structure d' ensemble*) did not profit from the training. They also purport to attach little value to the fact that my subjects were able to solve the problems again after periods of three weeks and six months, since noncognitive habits formed by conditioning can also be very stable. In this respect they contradict Piaget's words (Cornell paper) and Greco's practice.

Interpreting the acquired learning results as Greco's "quasi-notions," my critics demand additional tests, including resistance to counter suggestions, verbal explanations, and "farther" transfer tests. I shall do my best in future research. Investigators in Montreal have replicated my experiment, using more and better criteria (unpublished as yet). I hear that the results are positive, but I have not seen the details yet.

The discussions of the consequences of learning results acquired in experiments expressly designed to test Piaget's theory of how children learn new operations (gradual, coordinated interiorized action into a system of reversible operations) will certainly continue for several years. As I have tried to show in this paper, these discussions will be highly relevant for any theory of how children acquire new insights, and especially for a theory of guided learning such as this conference is striving for.

PANEL DISCUSSION

DR. SCHREIBER, *chairman of Group I:* We are rather confused as to relationship of Piaget's theory to guided learning. What of Piaget's theory is applicable to assessing guided learning techniques, or are Piaget's basic postulates concerning the spontaneous emergence of mental abilities contradictory to guided learning? Can one hope to alter the emergence of mental operations if one uses guided learning? Are there ways to assess ease of learning so that ages at which children can most profit from various kinds of teaching can be determined?

DR. KOHNSTAMM: I refer to the Jennings Lecture I gave to a group of teachers this past Saturday to demonstrate why Piaget's theory is fundamentally different from guided learning theory for several reasons. One, Aebli of West Berlin, who was a very bright student of Piaget and a school teacher in Switzerland, published his first book in 1951 on the application of Piaget's theory to education. Piaget's theory is enormous, and people looked with hope to someone who would apply this theory to education. Aebli was very optimistic. He said that Piaget's theory can be applied through giving the children experiences that lead to organization of their mental structures through acting on their material environment. He hoped to make this material environment good enough for children to achieve an optimal internalization of actions.

I'm not sure what happened after Aebli published this book, but his next book in 1963 is a stumbling block to the application of Piaget's theory to the classroom. Aebli had left Geneva. He now wrote that if the child had acquired the necessary operation by just acting on his natural environment, he did not have to be taught; if the child did not have the operation at his disposal already, he could not be taught. Piaget himself has never given much attention to teaching children.

As for the second question on the problem of ease of learning, you might say that if a child of five can be taught a concept but it is a lot of trouble, why attempt to teach him? We should find at what age learning is the least trouble.

DR. SCHREIBER: Which tests are available?

DR. KOHNSTAMM: No tests are available as yet because the psychology in this field was not based primarily on learning experiments with humans. This is what always surprised me. There is so little research on human learning, and in this field psychology has wasted a lot of time. Piaget has a very nice theory, but education can't use it.

DR. SCHREIBER: You said that Aebli at first proposed that children be exposed to a variety of experiences. Do the "dyed-in-the-wool" Piaget backers then refute that and state purely and simply that if children *have* developed certain functions, okay, and if they have not, one can not alter the state?

DR. KOHNSTAMM: No, they don't *say* that. They leave the idea that if you can give these children many experiences, they develop the concepts; but nobody tries to systematically alter their experiences. When I went to Geneva and visited around in the schools, Piaget and his workers were doing experiments with one group, and in the other room the kindergarten teacher was teaching the children. I asked the kindergarten teacher, "Do you use any of Piaget's ideas in your teaching?" He said, "No, we can't use them." He used Cuisenaire rods for arithmetic — something which Piaget was very much opposed to because they did not fit into the theory — and everything else that seemed useful in teaching. But even teachers so close to the center of the theory and Piaget's teachings could not apply these ideas. In England, Professor Peal and some others have tried to bring the theory into education. As far as I know, it hasn't worked very well because there are some basic difficulties which Aebli didn't see in his optimistic book of 1961. We see them now.

DR. KESSLER, *chairman of Group II:* We discussed the criteria for learning that were suggested this afternoon and thought they were reminiscent of criteria that were used to study the effect of maturation versus training back in the days of Gesell. This brought up the concept of readiness and how it is acquired, the timing of training, and the concept of "ease" in evaluating the usefulness of teaching something. The question of the group was, "What is meant by structure and how would you define structure?"

Dr. Kohnstamm: I will comment on these in turn. First, these criteria are a compilation of criteria which have appeared in the literature and have been used in relevant experiments. I added a few new ones and am thinking of others.

Second, Gesell is more on the maturational side than Piaget is. Those people down in Geneva always get very annoyed when you compare them with Gesell or with maturational theories. I am not too familiar with Gesell, so maybe you can get someone else to clear it up.

Dr. Schoer: Gesell's interest was not primarily with cognitive development. His was not a cognitive theory at all. He was concerned with motor development.

Dr. Kohnstamm: Yes, maturation plays a more important role in motor development than in cognitive development. Maturation does play a very important role with children under two years of age. Then other factors take over.

In regard to the question about structure, "pre-operational, operational" is very similar to "pre-logical, logical." In Piaget's theory concepts are all expressly kept vague. We may even want to keep our concepts of guided learning vague at the moment and concentrate instead on developing a climate for working and thinking about learning. Flexibility and vagueness are not good from a methodological view, perhaps, but they have advantages in that the theory is less vulnerable to attack. Therefore, "structure" has never been defined by Piaget. Flavell tried to define it something like this — a structure is considered to be a group of operations which are internalized action of a certain kind. These operations become structures if they can first be built up and torn down, and are coordinated, not isolated from other operations. This is why Flavell, for instance, says that Piagetian theory takes a wholistic approach. Piaget deals with organized structures that are composed of operations which are knit together, not because of classification, but because they have logical properties in common. Perhaps for education we need another kind of idea underlying structure.

Dr. McNerney, *chairman of Group III:* Our group is in favor of recognizing that a maturational hierarchy exists, but that it is frequently violated because of school organization. Aside from that, we would like to ask, " How does the Bruner philosophy and theory relate to yours, Dr. Kohnstamm, and how do both differ from Piaget?"

Dr. Kohnstamm: Bruner and Piaget had thought they could work together very well. Bruner went to Geneva and participated in some of the seminars they held on cognitive development. As we see it from Europe, when Sputnik went up in the air the Americans got very much concerned about cognitive development because they thought that they were behind the Russians, especially in education. Thus, a lot of money came to people like Bruner to organize seminars and to study and describe processes of cognitive growth.

Inhelder, who will be here at ERC to give one of the Jennings Lectures, is a right hand of Piaget. Inhelder worked with Bruner, and she participated in the *Process of Education.* They worked very well together because Bruner puts great emphasis upon creating a good environment and then leaving the child to himself to make discoveries. The concept of guided learning is not involved in any systematic way.

I think that last year Bruner may have changed his thinking. Several other people have. Miss Magali Bovet went over to Harvard and studied for a year there. On her return she told me about studies at Harvard using training methods which are never used in Geneva. Furthermore, language is viewed by Bruner as the main cause of cognitive growth. Language is not at all imporant in Piaget's theory. So, there are principal differences between Bruner's approach and Piaget's approach. As for my position, I know more about my ideas as opposed to Piaget. I agree with some of Bruner's later work and disagree with some of his ideas in the *Process of Education.*

Dr. Pritchett, *chairman of Group IV:* In studies which attempt to replicate Piaget's work, it has been found that, although transfer may occur within the same type of learning experiments, it may not occur across materials. Would you discuss these findings? We would also like you to comment on the usefulness of these criteria in judging the quality of concept learning in the classroom and on the role of language in Piaget theory and in guided learning.

Dr. Kohnstamm: Piagetian theory has often been criticized because, in replication studies, people found that if the child succeeded with one material one could not assume that he would succeed in another material. This criticism did not hurt Piaget's theory because of his mechanism of vertical and horizontal *decalages.* This is, in a horizontal *decalage* the child can show different levels of growth depending upon the content of his thinking. There may be a time in between the transposition and transfer of a concept. However, vertical stages seem to be more closely linked with age. These are concepts such as conservation of number, quantity, weight, etc. These concepts are hierarchial and require different operations. Thus, different concepts of the same nature but different complexity may occur at the same time. Operations which should occur at different ages because of different complexity can occur at the same time because of common operations.

As for the psycholinguistic approach, psycholinguistics is not important for Piagetian theory. Of course, it is very important for guided learning theory. I will leave it at that.

DR. OJEMANN: I think it might be well at this point to indicate that guided learning does not *depend* upon language. In other words, language is very important in the sense that it is very extensively used, but it need not be what mediates these experiences or brings these experiences to a child.

We need to get away from the idea that guided learning is all verbal because there has been considerable criticism of so-called "verbal" procedures, since meaning is often not attached to the verbalization.

DR. KOHNSTAMM: We all agree that guided learning theory should be eclectic in that it draws from all the methods and theories that will help it explain school learning. Thus, guided learning will use procedures appropriate to the learner and to the learning task.

The last question was, "Are the criteria that I use for these experiments useful for education?" I would like to ask that of the teacher. Psychologists and teachers each have a purpose in guided learning. The burden is on the psychologist to make this theory useful for education, but it is the job of the teacher to determine if they *are* useful. I would rather have it the other way — do you educators think these criteria useful to you in education? If not, we should leave them out of guided learning theory.

DR. OJEMANN: There is another group that you might be talking to and that is the fellows who construct the measuring instruments. This question is basic to a conception of the nature of the learning product that they should be testing for. If your criteria are used in testing, a wide range of different types of tests would be suggested.

DR. KOHNSTAMM: I agree. I think that the way we test intelligence and achievement at the moment can be viewed as "meter-reading" to tell how far the child has come. It is astonishing that there are so many people working on constructing tests for measuring intellectual growth and cognitive achievement, but none of them use these tests as learning situations. They never see how much the child can learn "if I help him" or use the results of this learning situation to *predict* learning in other situations. I am constructing some of these in Holland, but they are being opposed by psychometrists because these tests are not made "objective" and "clean." It is difficult to separate out the personality factors and the interaction between tester and child.

A good psychometric test can be given by a clerk or a machine, and the personal factor is considered "noise." Yet, the personal factor is very important for real learning. I think we need this kind of test, even though it may be sloppy, and we needn't fear this lack of objectivity. Objectivity is a mistaken concept anyway since we can't approach objectivity. So why not try to standardize as well as possible and attempt to be a neutral teacher? The climate is not favorable to the development of learning tests, but I think we need them.

DR. BLANKENSHIP: Could you tell us briefly what you think *is* relevant from Piaget theory which would be useful in the teaching situation?

DR. KOHNSTAMM: Piaget recently served as the main consultant at two conferences, at Cornell and on the West Coast in 1964, which were attended mainly by educators. Piaget gave three papers, which are published now in the report of the Cornell Conference, suggesting the importance of this theory for education. Duckworth, a former student of Piaget in Geneva, served as chief translator at this conference. She gave a paper at this conference, which she called "Piaget Re-Discovered." She suggested that Piaget's theory is very relevant for education.

Piagetian theory is rather good support for the Progressive Education advocates and those who believe in discovery learning. A good pedagogue, in Piaget's thinking, enriches the environment and then leaves the child to learn by himself. The teacher provides the instrument for the child to use to decide things by himself. Children themselves must verify experimentally in choosing deductively in mathematics, for example, because a ready-made truth is only a half-truth. Those in the progressive education movement would agree. Piaget himself says the teacher should not correct the child's schema — but should provide a situation where the child will correct himself. Piaget agrees with the Canadian who concluded that for every class we should have two classrooms, one where the teacher is, and one where the teacher is not. There are things in this Canadian report which make it very clear that the idea of his theory being relevant to education is just impossible.

DR. DAVIS: In a previous discussion you said that you did agree with Piaget's findings as to the importance of work in small groups as a means of helping young children break away from their inborn egocentrism. Maybe you will comment on that.

DR. KOHNSTAMM: Let me be clear — there are many things in Piaget's theory that are excellent descriptions of how cognitive growth works, especially in his theory of growth up to two years of age. I don't know a better theory or explanation for growth up to that age. Then things get a bit difficult because Piaget leaves language out. Language is very important from that age on.

Piaget explains how children are perceptually centered and also emotionally centered on their own viewpoints, as an explanation for their being egocentric. My own young children are very egocentric. If I didn't persist in educating them to become social beings, they would stay egocentric. Becoming a social being involves recognizing that others have a viewpoint, too, which may be different from one's own. Piaget demonstrated the child's tendency to expect others to see things from his own view. This is true not only in cognitive things, but also in emotional situations. Here I think Piaget is right. Putting children into groups and confronting them with different viewpoints helps break through egocentrism into socialization. Teaching children the different viewpoint is a great factor in the social education.

Piaget's theory is a beautiful system, really, and there are many things in it that explain many other things. It is not necessarily relevant to education, however.

DR. SCHOER: Vogotsky expressed in *Language and Thought* the view that up to about the age of two you can train the development of thought and the development of language as separate entities. But after the age of two a child begins to use so much language in his thinking that you can no longer separate the two. This view fits in almost perfectly with what you presented here.

DR. KOHNSTAMM: As you know, Piaget opposed Vogotsky's book. Vogotsky wrote the book in the 1930's (it was translated to English in 1962). And Piaget opposed these views in two of his books, *The Language and Thought of the Child* and *Judgment and Reasoning in the Child.*

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CHAPTER V.

Guided Learning Experiences and the New Curricula

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In order to assess guided learning in relation to the new curricula, we need to examine both as either implicit or explicit theories of instruction. The Association for Supervision and Curriculum Development Commission on Instructional Theory has developed a set of criteria for examining such theories, and this paper shall use part of that set as a guide. The criteria revelant to our concern are:

1) A theory of instruction should state the characteristics of pupils that are implied in the teaching procedures. These characteristics must be well defined, relevant to the instructional procedures, and demonstrated to be related to learning.

2) The instructional procedures must be specified together with the relationship that they have to goals.

3) Tasks involved in the instructional procedures should have identifiable characteristics specified in terms of task variables. (For example, verbal tasks should be specified as requiring a particular level of vocabulary.)

4) An instructional theory should include the identification of variables that are involved in moving from one point to another in the instructional process (or from level to level, phase to phase, stage to stage). Specifically, one might ask, "What assumptions, postulates, or hypotheses are evidenced in a theory concerning a) the nature of the child, b) the nature of learning, c) the sequencing of experiences, d) the selection of didactic materials, e) the nature of interpersonal relationships, and f) both the immediate and long range goals and purposes?"

GUIDED LEARNING

Let us first take guided learning as our measuring rod. How does this position answer the above six questions? Three main sources will be used: Ojemann and Snider (1964), Ojemann and Pritchett (1963), and an unpublished paper by Ojemann (1963) entitled "The Concept of Guided Learning."

The Nature of the Child

The guided learning theorist may be seen as holding five main ideas about the nature of the child.

1) The child is a cognitive information processor.

> "This investigation is part of the Preventive Psychiatry Research Program of the University of Iowa. One of the aims of this program is to develop a sequence of learning experiences beginning in the earliest years to help the child acquire an understanding and appreciation of the dynamic nature of human behavior; that is, to develop a causal approach to the social environment and to test the effects of such experiences" (Ojemann and Snider, 1964, p. 255).
>
> "The development of a program of guided experiences logically requires a theory of planned learning programs. There is needed a theoretical conception of what goes on in the central mental process . . ." (Ojemann and Pritchett, 1963, p. 930).
>
> "At the next session examples were given to evoke the generalization that two things can not be in the same space at the same time" (Ojemann and Pritchett, 1963, p. 933).

2) The child is a free agent who uses his already developed concepts to select activities.

> "Furthermore the pupil is free to behave as he wishes . . . Items were selected which involved behavior indicative of a sensitivity or lack of sensitivity to causes, alternatives, and probable consequences" (Ojemann and Snider, 1964, p. 255).
>
> "The reasoning underlying the selection of such an item was as follows: If the child were applying the idea . . ." (Ojemann and Snider, 1964, p. 256).

These items refer to the development of an observation form used to check on how effective the causal training experiences were.

3) The child basically is motivated by what White has called "competence motivation." What he needs to learn has to be seen by him as related to his present needs, the state of his emotions, and what he thinks is valuable to know.

> "The learning program began with a short discussion of the question, 'Why should we spend our time trying to figure out why things float?' " (Ojemann and Pritchett, 1963, p. 932).
>
> "Thus in the early stages of the guided learning situation . . . a probing as to how the child felt about the importance of learning to know . . . does he feel that learning to know . . .

> would help him to become a more capable person and if not could prior experiences be provided to develop this appreciation?" (Ojemann, 1963, pp. 5, 6).

In this theory, then, motivation is intrinsic to the child and related to the task only as the task is seen by the child as worthwhile. There is no assumption that involving the child in the task *per se* would be automatically motivating.

4) The child's development is seen as alterable by instruction. This is a basic proposition in this theory.

> "The purpose was to test the hypothesis that planned learning experiences can alter the course of development of the concept" (Ojemann and Pritchett, 1963, p. 930).
>
> "Such results raise the question as to whether the order of the development of the stages as outlined by Piaget is a necessary or inevitable order" (Ojemann and Pritchett, 1963, p. 939).
>
> "Whether children develop according to certain stages may depend on their experiences. Also, questions relative to generalization can be answered only in terms of the experiences that have been 'up to now' provided. What generalizations the child is capable of and what bases he can use can be answered only by investigating a wide variety of experiences" (Ojemann and Pritchett, 1963, pp. 939-940).

This theory is obviously in opposition to a purely maturational position, and we find Ojemann stating, very much as Bruner has done:

> "It would seem that a given child could learn almost anything providing a bridge of meanings could be built from where the child is at the moment to the specified goal" (Ojemann, 1963, p. 6).

This is somewhat analogous also to Hunt's concept of the problem of the match. (See paper by Hunt, this volume).

5) The guided learning theorist is unlimited by such concepts as attention span.

> "It may be well to note that the one-hour sessions did not seem unduly long for these age groups (five- and six-year-olds) when interesting materials in varied experiences were provided" (Ojemann and Pritchett, 1963, p. 934).

How Children Learn

Learning is seen as a result of the transaction occurring between the learner and the task. The design of the learning experience grows out of the analysis of both the nature of the learner and the nature of the learning task. There are five postulates.

1) Although Ojemann never uses the term, it is possible to infer Festinger's concept of "cognitive dissonance" as a major learning postulate for guided learning.

> "The group could easily observe that this reason did not produce consistent results, and another answer would be needed.
>
> "In like manner the other three responses were examined, and the session ended with the observation that 'we have to find new answers . . . the old ones didn't work' " (Ojemann and Pritchett, 1963, p. 933).

2) The use of demonstration and observation is the main guiding technique. Although the Ojemann and Pritchett study was of kindergarten and first graders, there is no indication that the children themselves handled the materials. It was not deemed necessary to handle the objects themselves. It seemed to be sufficient for them to observe the demonstration.

3) Verbal operations, regardless of the age of the child, are criterial attributes of this mode of instruction. In the beginning the children were asked to express *why* they should learn something. There are also tests of verbal understanding at the beginning of an experience.

> "Thus in the early steps of the learning program, there was not only a testing to determine whether the child knew the meaning of 'weight,' 'amount of water,' 'heavier,' and 'lighter.' . . .
>
> "As the children observed the demonstrations, the results were observed and the findings verbalized" (Ojemann and Pritchett, 1963, pp. 931, 933).

4) Central, of course, to a concept of guided learning is the importance of focusing. Indeed, the whole notion of guidance is the notion of calling the child's attention to certain materials in relation to others and asking him to deal with these relationships. In the statement we have received about the purpose of the conference this is made explicit. In Ojemann's discussion of the purposes of the specific gravity experiment he says:

> "In this sequence the learning was 'guided' in the sense that the 'guide' *suggested* that they try to see 'if the weight of water displaced had anything to do with the problem' . . .
>
> "The guide suggested . . . in other words the guide 'pointed the direction' . . . there was a searching by the children and a

> 'discovery' by them but the direction in which the search was made was not a matter of chance. " (See Ojemann, "Purpose of Conference on Guided Learning," this volume).

5) The variety of stimuli used both didactically and to elicit initial response is unlimited.

> "To guide the child in making this abstraction, a series of stimuli may be used; namely, words read (verbal stimuli), words spoken (auditory stimuli), demonstrations observed (visual and auditory stimuli), and activities performed (kinesthetic stimuli) (Ojemann and Pritchett, 1963, p. 931).

The Sequencing of Experiences

In this position, sequencing is under the control of the teacher. The teacher as a guide arranges matters. As we said above, sequencing is not left to chance. Further, the results of the sequencing, that is the nature of the concept to be learned, are known and determined by the guide ahead of time. Second, all experiences are ordered to lead to the concept. In information theory terms, they are stripped of "noise." Interestingly, as a third point, there is a notion of contiguity learning still resident in what otherwise might be conceived of as a nonbehavioristic approach. These sequences must occur rapidly and in a certain succession. The stimuli presented, for example, must be so arranged

> "that the excitations needed to form the combination represented by the meaning of the new concept are aroused simultaneously or in close succession. The process of arousing the excitations simultaneously must be repeated to give time for the combination of the essential aspects of the concept to form and to have a new symbol attached to this concept" (Ojemann and Pritchett, 1963, p. 931).

Although brain activity of the cognitive information-processing type is certainly implied here, there is nevertheless a residual of Guthrie's contiguity learning.

The Selection of Didactic Materials

The material presented above makes it quite clear that the didactic materials, combined with the guidance of the teacher, are critical to learning in this position. Only those didactic materials deemed necessary and sufficient for concept attainment are used. These materials are real objects. They are not games or models or precursors of real activity. For comparison, in the Montessori approach the child begins to learn how to write by tracing letters with sandpaper on them to learn kinesthetically. In the guided learning experience one would assume that the didactic materials necessary to learn writing would be inherent in the writing tasks themselves, and the results would be something in writing.

The Nature of Interpersonal Relations

There is no clear indication in either the monograph chapter or the Ojemann and Pritchett materials as to basic postulates about the nature of interpersonal relations. However, Ojemann's work in social studies suggests some ideas for us. If we examine the Ojemann and Snider study as well as the Ojemann-Pritchett work, it is obvious that it is materials that do the teaching. The teacher is the guide but not a giver of answers. Further, the teacher operates as a model of behavior. If the teacher behaves as though behavior were caused, a major condition for children's operating on this belief is supplied. In the attempt to examine whether children do operate on this belief, the observation schedule may be examined.

> "It was reasoned that the child who tries to understand is much less likely to label. It is more difficult to label when one begins to consider various hypotheses . . . the individual when understood usually turns out to be more complex than a label suggests" (Ojemann and Snider, 1964, p. 256).

One would assume then that teachers who operate causally ought also to be much less likely to label. In guided learning, teacher behavior would be designed to elicit understanding of the child's level of ability, his emotional state, and the nature of the tasks which he is ready and willing to learn. It would then shift to require that the teacher guide the learner through a given set of experiences leading to the attainment of the skill, concept, or information desired.

Goals

One might hypothesize that the long-range goal is the building of intellectual structure and the modification of development of the child. It does not seem, in this system, that one is to learn a specific body of subject matter for its own sake. One learns only because the information, skill, or concept is of use to the learner. Further, a long-range goal is the transfer of learning through the ability to deal with more complex problems and issues based upon the already developed intellectual structure. One infers that the ultimate aim is the building of a more adequate adult who will be able to modify his environment. In Ojemann's monograph this is suggested:

> "The available evidence suggests as a possible hypothesis that it may be possible to design cognitive learning situations

which produce extensive changes in the organism" (Ojemann, 1963, p. 14).

THE MADISON PROJECT

We now turn to Robert Davis's Madison Project in Mathematics as one example of a new curriculum. How would Davis answer the above six questions?

The Nature of the Child

1) It is clear that Davis agrees with Ojemann in seeing the child as a cognitive information processor. He is concerned with the development of concepts rather than with the learning of isolated facts. For example, in his instruction to teachers he says:[1]

> "Try to get the student to think about the basic concepts as early as possible . . . he can learn names and calculations later on, after he has thought about the concepts in a creative way for some time. . . . every effort should be made to get the students thinking and talking, *not* listening and accepting" Davis, 1964a, p. 18).
>
> "In the first place, an orientation based upon the notion of the *gradual modification of the individual's internal cognitive structure* appears to us as highly appropriate for studying the learning of mathematics" (Davis, 1964b, p. 16).

2) There is no analogous point two to the position taken in guided learning.

3) The Madison Project uses curiosity as its main motivational concept, although, as we shall see when we look at learning, it also utilizes its own brand of positive reinforcement.

> "It is clear that many fifth graders 'think like scientists' — they want to get answers to questions for direct intellectual satisfaction . . . the scientists, and the fifth grader, are motivated by curiosity — are excited by intellectual adventure" (Davis, 1964a, p. 2).
>
> "The fact is that children learn because they are free, because they are respected, because they live in a good town and go to a good school and have good teachers. They learn because they want to learn. They learn because, on the one hand, they are happy, and because, on the other hand, intellectual challenges are abundantly present in many attractive forms" (Davis, 1964a, p. 7).

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[1] Quotations are used by permission of the Addison-Wesley Publishing Company.

4) In reference to the alterability of development by instruction, the Madison Project assumes that, in mathematics, school experiences are essential.

> "Since ordinary life fails to build readiness for the study of mathematics, this task devolves upon the schools" (Davis, 1964a, p. 4).

5) The role of maturation is almost seen in reverse by Davis. The position is taken that pre-adolescents are far more ready for the introduction to abstract learning than are adolescents. Pre-adolescents are seen as more theoretical, adolescents as more practical. The introduction of abstract experience should be earlier in the grades. There is the assumption that readiness builds on earlier experience and that this experience, in mathematics at least, must be encountered in the school. Davis states in effect that readiness for language can be built in the home since it is part of natural growing up, but that the type of abstraction required in mathematics does not come naturally to the child in ordinary living.

> "The student has *not* lived in a world of ubiquitous quadratic equations. For him, the vocabulary, symbols, concepts, techniques, objectives, structure, and conventions of mathematics are entirely new" (Davis, 1964a, p. 3).

How Children Learn

1) The notion of positive reinforcement permeates the thinking behind this project, although Davis does not say so. It is not positive reinforcement in the same way that Skinner would talk about reinforcement schedules, but let Davis's words speak for themselves.

> "When a student's statement contains a largely correct idea couched in somewhat uncertain language, *we nearly always respond to the positive part of his behavior* — namely the correct idea. We do not (well, hardly ever) respond to the wrong part of his behavior, in this case the doubtful verbal formulation" (Davis, 1964a, p. 15).
>
> "We want an *encouraging* word from the teacher . . . we do *not* want a *discouraging* word from the teacher" (Davis, 1964a, p. 16).

Under the heading of the provision of success experiences, he cautions the teacher.

> "Nearly every student's answer has some merit if only as a courageous try. Attempt to respond to every student's answer as a scientist might — it is an answer and it deserves respect" (Davis, 1964a, p. 19).

It is, however, important to know that the teacher's response is to be guided, not by the correctness of the answer, but by the spirit of encouraging the child to continue to try.

The child in the Madison Project classroom is expected to utilize trial and error learning as a part of the discovery of a concept. In an early lesson, the children are expected to deal with the following problem: "What number can we write in the $\square$ to make a true statement?"

1. $3 + \square = 5$
2. $8 + \square = 12$
3. $5 + \square = 16$

In Davis's instructions to the teacher he says, "The method by which the student will solve these three equations will be by guessing, trial and error."

2) In place of demonstration and observation, Davis stresses experience and participation. Indeed, if there is a key concept in his approach, it is this ambiguous notion of experience. Sometimes one infers experience for experience's sake, although this is really not what Davis is after. He says:

> "In general, there are two kinds of experiences which we provide for the children: experiences where children *do* something and experiences where a 'seminar' of children *discuss* something, under the leadership of a teacher. Both kinds of experiences are so different from usual 'mathematics lessons' that we have had to give them a distinctive name — *informal exploratory experiences*" (Davis, 1964b, p. 3).

Experiences are often seen as the end as well as the means. There is, however, a set of criteria for choosing experiences. In outline form they are as follows: (1) there must be adequate previous readiness, (2) there must be relation to fundamental ideas, (3) the student must have an active role, (4) concepts must be learned in context, (5) interesting patterns must lurk under the surface of the task, (6) the experiences should be appropriate to the age of the child, and (7) the sequence of "informal exploratory experiences" must seem to "add up" to something worthwhile. The last point would seem to indicate that both the building of intellectual structure and the notion of the structure of discipline have to be assessed in determining the worthwhileness of an experience.

3) Group discussion is a main vehicle for conveying experience. There is not necessarily physical activity in the usual sense of dealing with concrete objects, but there are discussions among the children in relation to an abstraction that may have been placed upon the blackboard.

4) Guided learning, stressing the importance of focusing, would seem at first look to be the antithesis of discovery as viewed by the Madison Project. For example, as an explanation of why curiosity seems to be lost between childhood and adolescence, Davis says,

> "In academic learning the child finds that he has lost the the initiative and that he is surrendering an increasing portion of his independence. He is learning what *grownups* think he needs to learn; he is operating under the direction of *grownups;* his work is being evaluated by *grownups;* and the goals and values have been determined from the *grownup* world. . . . *Initiative* presupposes *independence*" (Davis, 1964a, pp. 4, 5).

Sometimes a superficial view of the Davis project leads to the notion that all learning is fun and games, with no pay-off. His instructions to teachers resemble very much Montessori's instructions to her teachers!

> "What we *can* do is to try to observe ourselves as carefully as possible and watch to see which error we make most often — allowing too much drifting or imposing too much adult interference. We can attempt to practice self restraint, to avoid too much teacher talk and too little child response. We can attempt to observe children while teaching, to avoid pushing too strongly in *our* direction, too weakly in their direction. We can also remember the observation of an astute teacher: 'Children can not *choose* to do something they have never even heard about. We must acquaint them with many attractive alternatives if they are to exercise any right of selection' " (Davis, 1964a, p. 6).

The Sequencing of Experience

The teacher plays a central role as the organizer of experience, although this seems to be more an art than a prescription. Davis defines a teacher as a moderator or a discussion leader, as one who asks a series of leading questions and as one who observes and listens to children.

> "An important feature also is the device of asking the children a carefully devised sequence of questions, which gradually lead them to formulate techniques of solution and to discover generalizations" (Davis, 1964a, p. 8).

The sequence is controlled by the nature of the subject matter.

> "The teacher has tried to remove himself from the role of middle man: he has tried to step out of the way, and let the child look directly at the mathematical structure itself" (Davis, 1964b, pp. 5, 6).

2) Although the child may have the impression that the experience is haphazard, and although there is no real effort to strengthen the sequence and eliminate all "noise", nevertheless the sequence is determined by the structure of the discipline. This is what the child is to discover.

> "Only the most consistent 'poker voice' and the careful withholding of cues and answers really leave it up to the child to discover the internal organization of the subjects" (Davis, 1964a, p. 9).

The teacher is not to give answers or to let the child know exactly what is expected or to be discovered. Davis says,

> "In our 'experience' lessons we structure the situation as little as possible. . . . in our 'seminar discussion' lessons there is at once an appearance of a relatively highly structured situation, and at the same time an appearance of great flexibility. After wondering about this seeming paradox for some time, we have come to believe that the 'good' Madison Project teacher possesses, in his head, the ability to construct suitably designed 'branching programs' at a moment's notice (Davis, 1964b, p. 11).

The Selection of Didactic Materials

There are no concrete materials utilized in the sense of the manipulation of objects. The main material is quadratic equations, in which a graph is used. Sets and equations are also the beginning point of the work. The experience provided for these youngsters is often through a guessing game or games, such as a modification of Japanese "Go." These are not practical materials in the old sense of learning to grocery shop; they are abstract and theoretical, in keeping with Davis's view of the pre-adolescent as an intellectual being with curiosity. Nevertheless these materials are concrete in the sense that the child can assess his answer against whether it works or not, rather than relying upon authoritative judgment from the teacher. In this sense the materials serve as self-teaching devices.

The Nature of Interpersonal Relations

There are positive injunctions in the Madison Project for how the teacher is to behave. The teacher is an encourager and respecter of the child, providing a warm accepting climate. The program is seen as successful because:

> "The teachers like children, and they respect learning and maturity and resourcefulness. The children are treated with the complete respect that every human being should receive, but which is ordinarily reserved for adults. The child in these

schools is not reprimanded for not saying 'thank you' but his superiors would be very sure to say 'thank you' to *him* whenever he has handed them something or has done something for them. It is for the child to decide what attitude he will take toward his superiors, but their attitude toward him is to respect him as an equal, and a friend" (Davis, 1964a, pp. 6, 7).

Goals

Again Davis's words can speak for themselves:

> "We are not primarily concerned that children should learn facts and routine techniques. We are particularly concerned that they learn creative problem solving, the ability to discover patterns in abstract situations, that they come to a realization that mathematics is indeed *discoverable*, that they acquire faith in their own personal ability to make mathematical discoveries, that they acquire self confidence, that they acquire an honest self-critical ability, and that they come to regard mathematics as 'fun' " (Davis, 1964a, p. 11).

Further,

> "Topics are chosen to provide experiences with fundamental concepts and techniques with which the children should become familiar, which provide for active participation, and which should provide abundant opportunities for the children to make discoveries" (Davis, 1964a, p. 19).

and,

> "The aim is for nothing so trivial as a 'level of achievement' " (Davis, 1964a, p. 20).

A key purpose is to immerse youngsters in mathematical experience so that they will become familiar with the concepts *indirectly* and so that they will then be able to utilize them without necessarily being conscious of their knowledge.

> "We have mentioned two kinds of knowledge: the unreliable kind that is embodied in rules and the more versatile kind that is embodied in pseudo-geometric mental pictures. But there is a third kind that is so secure, so reliable, and so easily available that we are hardly aware of it. This is the kind of knowledge that is represented by experience" (Davis, 1964a, p. 3).

Essentially there are some parallels between the Madison Project and guided learning, but there are also some interesting differences. Nowhere is it clear that children are ever asked in the Madison Project *why* they should wish to learn whatever is being presented. It is assumed that curiosity is a sufficient beginning motive and that competence will take care of itself, although certainly competence is a goal. There are no concepts of transferability, and what is to be discovered is to some degree left to chance. There is further, to use Davis's terms, "no specified level of achievement." In this respect, what is learned by each youngster is highly individual. Davis is not concerned with verification.

A major agreement is on the notion that fixed maturation must be called into question, and that instruction or experience of particular kinds may very well lead to modification of cognitive structure.

Biological Science Curriculum Study (*BSCS*)

As an example of "the new science" I have selected BSCS because over the years I have had some continuing experience on its fringes. The large amount of material produced by BSCS makes it impossible to review it thoroughly in the short time available here. The main sources of data are *High School Biology*, *Teachers Commentary*, *the 1960 Summer Writing Conference* and the current green version of the text and the laboratory manual.[1] The latter were reviewed by Marie Churney, a student of mine who was seeking to evaluate its use of "discovery."

Whereas the assumptions used by Ojemann and Davis are explicit, the assumptions underlying BSCS are somewhat implicit, and there are many blanks in our outline.

The Nature of the Child

The child is seen as an information processor and an enquirer. But, what a child learns is not necessarily a function of what he wants to learn or what is useful to him.

> "In more recent times the view was common that the high school should teach only what students *wanted* to know or only what was clearly immediately useful in the students' local community and circumstances" (BSCS, 1960, p. XI).

The concept of needs used by BSCS are all in the cognitive domain.

> "We need to understand systematic theory, we need to learn to discriminate between data components and conceptual components of our knowledge. We need to follow the arguments which lead from data to conclusions. We need to be able to handle alternative formulations of knowledge rather than single 'truths.' We need to understand the reasons why one formulation is preferable to another. And we need to understand why

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[1] Quotations are used by permission of the Biological Science Curriculum Study.

> and how formulations change. These needs are a far cry from the 'coverage' and docile learning which have characterized so many science texts and so much science teaching at all levels. They demand, rather, the following of enquiry and participation in the solving of problems" (BSCS, 1960, p. XI).

There is really nothing else said about the nature of the learner as far as this reviewer could determine. There are no clear-cut notions about the role of maturation, about instruction as a modifier of development, about limits, or about the freedom of the learner.

How Children Learn

1) Neither cognitive dissonance nor positive reinforcement is clearly indicated. Indeed the position is unclear, except for the vague conception of "discovery" and activity. There is a notion of some sort of information processing that occurs as a result of interaction between a learner and a set of materials, but certainly nothing can be neatly packaged and labeled.

2) The process to be used is very clear. It is to be one of enquiry and discovery. There are demonstrations, observations, and experiences in participation. As Churney indicates, there are 12 characteristics which might be thought of as indicative of a discovery approach. These are:

1. Concepts are presented by the inductive method.
2. Concept presentation is initiated by a problem situation.
3. The materials encourage active participation of the learner in textual as well as laboratory investigations.
4. The materials are structured to raise questions in the mind of the learner.
5. The structure demands that the learner organize his knowledge.
6. The structure encourages the learner to ask questions utilizing previous information.
7. The materials present the student with new information.
8. The learning environment, not the learner, is manipulated.
9. The structure allows for differences in the student's level of cognitive development.
10. The generalization to be learned is withheld from the learner so that he can discover it for himself.
11. The "discovery" made by the learner is not necessarily new to civilization; it is new in relation to the previous cognitive development of the learner.
12. The investigative procedures used are open-ended; the teacher does not know all possible results and explanations which may grow out of a presentation.

Churney's analysis of the green text and laboratory manual indicates that BSCS makes extensive use of presenting concepts by the inductive method — initiating concept formation by using a problem situation and by presenting concepts through active learner participation, through raising questions, and through presenting new information. She says the laboratory has a total effect of moderate accomplishment of the methods of discovery learning.

Let us look at two concrete examples in the section labeled "Invitations to Inquiry" in the *Teacher Commentary* (1960). The first deals with the meaning of classification.

> "Purchase a number of packets of assorted stamps. Any other objects which present at least three different characteristics, such as color, shape, and country of origin, as in the case of stamps, will do. Divide your students into five to 10 groups and give each group a packet of stamps. Ask each group to classify its batch of stamps. If they ask, 'How?', tell them to do it as they wish.
>
> "When the classifying has been done, ask a member of one group where he has put stamp X. (Select your X so that it is conspicuous enough to be found quickly by the student.) By 'Where?', students will understand either the class characteristic (in the 'yellow' pile, in the 'square' pile, etc.) or they will answer by saying, 'with the German one,' 'the other yellow ones,' and so on. Now ask a member of another and then another group until it is clear that different groups have classified by different principles: some by color, some by country of origin, and so on.
>
> "Now ask, 'Which of these classifications is the right one?' Let students try to defend one or another principle until the point can be made that any way is right, depending on the purpose for which the scheme is to be used" (BSCS, 1960, pp. III-1, III-2).

A second illustration deals with sampling.

> "The description in the text has been written so as to 'bracket' a very important omission. There is no mention of the way in which the experimenter determined how many mice were where at what times! Yet the entire conclusion rests on this determination. This omission provides an excellent opportunity for participation by students in the problems of enquiry. We suggest something like the following procedure.
>
> "When this section of the text is assigned, announce to your pupils that the paragraphs in question involve a glaring omission. Tell them that the omitted matter is crucial to the experi-

> ment: it is something which could easily be done badly, and if so done, it would throw great doubt on the conclusion. Challenge the class to locate the omission (as part of the general class assignment or in special projects assigned to a few).
>
> "Whether all students, only a few, or even none, find the omitted item is relatively unimportant; the challenge to treat a text as something other than an unquestionable authority is itself important. The experience of close and critical reading is another important educational gain.
>
> "This next phase can be structured as follows: now that the omission has been identified, invite some or all students to think of at least two ways in which a daily estimate of the mouse population could be made by sampling. (You probably will have to explain what is meant by sampling. If so, you might use the techniques of 'market analysis' used by merchandisers. They may pick out one in every 10 people entering a single supermart and ask him whether he prefers Brand A or Brand B — then treat this 10% as a fair sample of the city's buyers.)
>
> "You will probably have to lead the students by roundabout suggestion from the market analysis analogy to methods applicable to the sampling of mouse populations.
>
> "At the next meeting of the class, call for sampling proposals. Invite the whole class to begin the task of critical examination of them. (You may need to start the ball rolling by showing one potential weakness of the first method proposed.) The sampling methods suggested may range from ridiculous ones to unexploited possibilities of great potential usefulness. Consider carefully the merits of suggestions by encouraging the students to evaluate each one critically and by contributing yourself where reasonable" (BSCS, 1960, pp. III-21 — III-23).

Note in this second exercise that this discovery is not completely autonomous but clearly is guided by the teacher.

3) Words are important in biology, both in their classical taxonomic forms to which we were subjected as students and in their modern conceptual design as presented by BSCS. Labeling, categorizing, naming are all very much part of the game. Group discussions help, however, and seem to be indicated in the various materials developed by BSCS.

4) There is focusing on relevant materials, but these materials have been selected as illustrative of principles. In some way this is analogous to the Ojemann-Pritchett experiment on specific gravity. However, the focusing in BSCS seems to be less sharply defined. It is quite possible in the laboratory exercises for students to be distracted by "noise", to be

bogged down in the detail of the experiment, to be involved in several experiments at the same time, and to lose track of the ultimate aim. I remember, when reading the 1960 materials, being overwhelmed with the variety of operations in which pupils were expected to be engaged at one and the same time. The principles upon which they are to focus are also at rather high levels of abstraction, and it may be that exercises in which youngsters engage are several steps removed from the principle. For example, in the genetics material, one might question whether the amount of computation is readily essential for understanding the principle of genetics. The mathematics may get in the way of the biology.

5) The variety of materials makes use of the various sense modalities as indicated by Ojemann. There are certainly kinesthetic, verbal, and visual stimuli present, particularly in the laboratory, and, with formaldehyde, there may also be olfactory stimuli present.

The Sequencing of Experiences

The example given earlier of learning 'sampling' indicates something about the sequencing. However, there is obviously a conflict among the biologists as to which basic principles to center upon and what ordering of materials is desirable. The existence of green, yellow, and blue versions, which sometimes use the same materials but arrange them in different order, would certainly indicate tremendous research possibilities for the investigation of appropriate sequencing of materials in biology. It might also be indicative, subject to research, that sequencing really doesn't matter. Whatever sequencing there is seems to be under the control of the teacher, but just how this control is exercised is not clear.

The Selection of Didactic Materials

The laboratory materials particularly seem to have been selected with a notion of what is necessary and sufficient for concept attainment. The student deals with real objects, as in the Ojemann work, and he tests principles. He finds out and develops his notions from what happens to these materials as he works with them. The materials seem to be selected also to teach him notions of probability and the changeability of science. They do not seem to be selected to represent fixed answers to fixed questions.

The structure of the discipline of biology, organized around principles of enquiry and defined as conceptions which serve as guiding functions, is the central material to be learned. These principles are the principles of process, of change, of motion and action, of beginning and end, of matter and organization, of whole and part, of chance as a "cause."

The student uses the didactic materials in controlled situations to develop or to discover for himself the existence of these principles, rather than having them stated in, to use Ausubel's term, "advanced organizers" for him. Through the manipulation of the didactic materials, he is expected to develop his concepts.

The Nature of Interpersonal Relations

It is in this area that BSCS gives no information beyond the idea that the teacher is to encourage and challenge. There seems to be no understanding of the role of affect in learning or any concepts of classroom climate. I suspect this leaves teachers free to interpret and behave in any way they wish. There might then be great discrepancies between what is written in the textual materials and the mood and spirit in which life is lived in the classroom. This is not meant as a criticism, since this was not a key focus for BSCS. It indicates that the BSCS has incomplete assumptions about classroom behavior and learning.

Goals

One would suppose a major goal is learning to learn, that is learning how to enquire so that one may continue to enquire throughout his life. There is some notion of application to social problems, but certainly the didactic materials and textual materials do not indicate any way in which biology is transferable to such problems as conservation, water supply, and air pollution, for example. Perhaps a very brief line from the *Teachers Commentary* will indicate the goal:

> "In the development of a sound sense of the nature and values of science, may lie the new responsibility of science teaching" (BSCS, 1960, p. XIII).

To explicate this, scientific knowledge is analyzed for its utility. Some knowledge is seen as truly of long term usefulness because it provides the germs of tomorrow's science and the raw materials for exciting and challenging problems. Some bodies of knowledge must be included because they derive from experimental enquiry and are largely macroscopic, concrete, and reasonably familiar. In addition the latter offer,

> "Ideal teaching media for conveying a sense of the ordered knowledge which is the crown of scientific enquiry" (BSCS, 1960, pp. XII, XIII).

It is clear from the above quotations that the major goal is a content goal, if we include the process of enquiry as a content goal. It is not to change the learner or to have him feel that biology is fun or to develop his general intellectual capacity. The main goal is to enable him to learn the structure of the discipline of biology, in effect as a biologist learns it.

CONCLUSIONS

Of course any such brief review as the above does injustice to all three positions: guided learning, the Madison Project, and BSCS. One of my main purposes, which may be my long-range goal, was to present to you a model as to how one can compare some current materials, a way to abstract and organize what they have to say in order to see where they agree and where they differ.

It seems that one of the main problems curriculum people face is to create some internal consistency in their programs. To do so, they must analyze the theory of instruction inherent in the marketable supplies and programs being suggested to them. They need to be able to examine these offerings so that they will not use completely disparate systems unknowingly. The problem they face, if I may be forgiven a pun on Hunt's excellent term, is the "problem of the mesh."

GENERAL DISCUSSION

DR. OJEMANN: What is the rationale underlying the selection of criteria you presented?

DR. GORDON: I am a member of the ASCD Commission on Instructional Theory. We asked, "How will you know an instructional theory if you get one? How do you decide whether to accept a theory?"

First we considered the nature of the learner. We said that a theory of instruction should take into consideration the characteristics of the pupils. These characteristics must be well-defined, relevant to the instructional procedure, and demonstrated to be related to learning.

Second, we considered goals. The instructional procedures must be specified, together with the relationship that they have to goals.

Third, the task involved in the instructional procedure should have identifiable characteristics specified in terms of task variables. For example, verbal tasks should be classified as to the particular level of vocabulary required.

Fourth, an instructional theory should include the identification of the variables that are involved in moving from one point to another in the instructional process. This is where we get the notion of sequencing, etc.

The Commission has described the criteria. Its next job is to write a paragraph describing each and print it in booklet form.

We have also checked the Montessori method of education against our criteria and, although we approached her method with hostility, we were quite amazed. If you want what is probably the most complete theoretical statement about instruction — although it may not be correct — I refer you to Maria Montessori's writings. Her statements have a lot of internal inconsistency measured against these criteria, but they hold up surprisingly well.

Dr. Ojemann: After having used these criteria, how do you feel about them? Would you like to modify them?

Dr. Gordon: The ASCD Commission has the task of clarifying all ideas and then trying to communicate them in a way that will be received and understood. We had a difficult task in constructing these criteria and they were extremely useful in evaluating the materials I discussed tonight.

Mr. Willford: Do the same criteria hold for, shall we say, skill development as opposed to concept formation, or do you differentiate between kinds of learning?

Dr. Gordon: I think the criteria can be applied equally to many kinds of learning because the criteria are not specific. Even in skill development you still have to ask, "What do you think the child already knows? How do you think he learns, and what kind of operation must he go through?" These questions relate regardless of what the task is.

Mr. Cunningham: Why did you choose to discuss the Madison Plan? This is a sequential course in biology primarily, yet it includes some math concepts that may or may not be worth teaching in the elementary school.

Dr. Gordon: I think there are two reasons. First, I am familiar with it. Secondly, Davis has written a paper in which he talks about the plan as leading to a theory of instruction. This is something most of the others have not done.

Perhaps you would like to see how a good sequential program in math stacks up against these criteria. I can't evaluate the Greater Cleveland Math Program (GCMP) K-12, because I am not familiar enough with it. My hope is that you will take these criteria and evaluate GCMP yourself. I only had time to go through Book I, but I did discover that one can use these criteria to evaluate this program.

Dr. Schoer: Are you thinking of a comprehensive theory of guided learning that would cover all types of learning and all subject matter areas?

Dr. Gordon: No, I am really not talking about an ASCD theory. Regardless of the type of theory developed, this form of analysis could be applied to it. The analysis is not specific to a particular kind of theory. The ASCD Commission clearly felt that at this stage no one should even be thinking about a universal theory in instruction.

Dr. Gilchrist: Does that mean that you'd like to stimulate us in our respective groups to arrive at what we think our theories are?

Dr. Gordon: Yes, we would like you to make explicit what is already implicit in your material. You can't produce material such as the GCMP without having an implicit theory. Any course of study implicitly contains the developers' particular answers to those six questions, whether the developers know it or not.

Mr. Jennings: Would you explain a little more thoroughly what you mean by cognitive dissonance?

Dr. Gordon: I don't know if I can explain it as well as Festinger. This is coming to grips with information that forces one to recognize and acknowledge something that is in disagreement with the position he has already taken. This places one, if I may use a Piagetian term, in "disequilibrium" — in effect, forces one to "accommodate" rather than "assimilate." If we get back to the specific gravity paper, for example, you say a thing is going to float because it is big, and, lo and behold, it sinks. The sinking of a big thing is dissonant with what you expected to happen.

Dr. Torrance: This was really the central method of Socrates.

Dr. Kohnstamm: Do you want to create dissonance?

Dr. Gordon: Yes, I do.

Dr. Kohnstamm: Do you use it as a tool?

Dr. Gordon: You can judge only from what my students say, and that is, that they never get over it. They sometimes get so much dissonance they get hostile.

Some of you may have been unhappy with us speakers because we created confusion last night and this morning. This can serve a good purpose. You must start with getting "shook up" — shifted from your nice comfortable position before progress can be made.

Dr. Kohnstamm: Is this only for adults or is it also for children of say five?

Dr. Gordon: For everybody — children of six, two, one . . .

Mr. Willford: You have five points under the heading "The Nature of Learning." One of these is cognitive dissonance. The other four points, it seems to me, apply to instructional strategy. Cognitive dissonance is the only one listed that is a motivating force, a source of energy, let's say, of the organism. Are the other four points ways in which to satisfy the cognitive dissonance or to cause equilibrium? Listing all of these under the same heading is a little confusing to me.

Dr. Gordon: I think you are right. I would see the other four factors as strategies that create dissonance, that help to resolve it, and that create it again in the next situation. You move along, you see. Thus, the child thinks he has an answer and then discovers that he doesn't. Then you engage in finding out what led him to realize that his generalization (answer) is inadequate and set up a sequence of tasks leading to another generalization. So the four points have become devices or tools.

Mr. Willford: In all the various types of learning behavior there are a number of different kinds of motivating or propelling forces. Why did you pick this particular one? Is this meant to describe and to explain all human behavior?

Dr. Gordon: I think that Dr. Ojemann's concept of guided learning — whether he acknowledges it verbally or not — makes use of this. I am not saying that I see this as the only way kids learn. As I understand his position, cognitive dissonance is an important motivating force in guided learning.

Participant: Would you enlarge on your understanding, from the guided learning point of view, of the importance of "usefulness" of what is to be learned — perhaps discuss the BSCS approach to the word "usefulness"?

Dr. Gordon: You can look at this two ways. You can talk about a youngster's discovering in the material its personal relevance for him; or you can talk about his discovering the structure of the discipline. I think in guided learning when you ask the youngster, "Why bother?" you hope he will find something that will enable him to say, "Aha, there's something in it for me!" In my opinion, in much of the new science — not just BSCS — the hope is that the youngster will discover something in the discipline *per se.* What he may discover isn't necessarily *personally* relevant at all. What I mean by "usefulness" is the level of personal meaning that something has.

I think as a whole the BSCS has made a tremendous contribution. But if we analyze adolescents we must say, "What is the nature of the adolescent?" Some principles or some illustrations of some tasks have a high personal relevance to the adolescent and can be selected as devices for getting at the same principles that the BSCS wants to teach. However, they are not the ones that are used. For example, for the notion of the cycle, which is an important concept, the writers apparently picked illustrations that can be approved in the 50 states. But I would think that there are two cycles that are critical to the adolescent — the growth cycle and the reproductive cycle. BSCS talks about some innocuous digestive processes, and even then, these processes are treated in a manner which is remote from the "gut-level" way that adolescents are living. I think BSCS could increase its utility value. The reason that we've had to develop a slow-learning series is that the kids say, "There's nothing in biology for me." In a good "guided learning operation," which analyzes the nature of the learner and the nature of the learning task, the youngster would not be able to make that kind of statement.

Participant: How can we take into account the differences in subcultural values and experiences in developing the curriculum with personal relevance? I think we recognize that what has value in Shaker Heights, for example, won't necessarily have value in Garfield Heights. (Editor's note: These are two Cleveland suburbs illustrating different socio-economic bases.)

DR. GORDON: That's a very important question. I personally see no reason why the child from Garfield Heights should learn the things that the child in Shaker is learning. I am sure there are a great many people who would not go along with that.

MR. CUNNINGHAM: Maybe your criteria would be better used in examining the actual "how the teacher teaches the program" rather than in the program itself. I can just see one of our teachers teaching your experiment in mathematics. "Today, children, we will *discover* how to categorize stamps according to color. Tomorrow we will *discover* how to categorize them according to country."

DR. GORDON: Your point is fair. There is often a far cry between what is going on in the classroom and what is printed in the book. If you talk about instructional theory, obviously your data base cannot be the printed curriculum guide. It must be the teacher's behavior in the act of teaching in the classroom. If you attempt to use these criteria — if they have any relevancy at all — study not only what your printed materials say teachers should do and what sequencing you ask for, but also study *which* of your GCMP suggestions are used and *how* they are used.

DR. GILCHRIST: Is there the suspicion of a sad discrepancy between what is taught and what is said that has led you to this valiant effort to be explicit?

DR. GORDON: I think so.

DR. GILCHRIST: I understand why your Commission does not want to write a theory of instruction and try to impose it on everybody in the country. Would the Commission object if different groups — like your Commission, like the Educational Research Council — all over the country think about this? Maybe in ten years there would be many common elements in the theory of instruction upon which we could try to operate. Out of this work might come some guidelines for education that might make us a more respected profession. Or am I just naive?

DR. GORDON: Not naive. I think you are an optimist. If you look at all the attempts reviewed by Torrance you will see that, in the long run, theories are made by individuals. I am not an organization man in this respect. I am here because I think Dr. Ojemann is one of those individuals. He has sometimes worked with great opposition. He has plugged away for 20 some years at something which is just now beginning to get organized into an initial theory. That takes a lot of time, a lot of work, a lot of data; and the data still are not present for most of what we are trying to do. I would hope that individuals would begin to gather data, and that gradually figures would emerge. But I don't expect that the Council or commissions or regional groups will do this.

MR. SUGDEN: Isn't it accomplishing something important if the child can be made to go "outside himself" and realize that all the world does not relate to him, but it is still interesting and important to learn about? That is, how far is it necessary to relate a thing in any practical or para-practical way to a child's life?

DR. GORDON: We could get into a metaphysical argument about whether any knowledge exists apart from the knower. Dr. Hunt, were you going to come to my rescue?

DR. HUNT: We want to take seriously the notion of formal operation and the notion, with it, that thought directs observation. The question then becomes whether the learner's hypotheses *do* concern what's out there or whether he is able to view the world as it *might become* rather than as it *is*. When the learner has this capability, I think there is the possibility of this kind of thing you're talking about. Notice there is still a subjective element. There still has to be some kind of incongruity between the attitude or belief the youngster *holds* and the kind of information that he is *being fed*. If the information is irrelevant to the youngster's beliefs it makes no incongruity at this point. The question is, what optimum of dissonance or optimum of incongruity is the motivating force for the information processes.

DR. SCHOER: The situation that was described also depends on the desire for knowledge *per se*. You have some children who have had a sufficient number of satisfying experiences while acquiring knowledge and thinking of abstractions; therefore this kind of manipulation is satisfying to them. The knowledge doesn't have to be immediately applied for them. You have other children who have not had satisfying experiences; therefore this kind of manipulation is not satisfying. Now we're back to the question of Shaker Heights vs. Garfield Heights. For many children in Shaker Heights knowledge for knowledge's sake is satisfying. They have been rewarded for this kind of thing. On the other hand, we have other talented children who come from homes in which ideas are not important for their own sake. Notice that we are still dealing with something that is of personal relevance and is satisfying to the individual.

MR. WILLFORD: Are you or your Commission going to attack this problem of objectively measuring the child's ability to select his own learning tasks and the degree of freedom he has to use this ability?

DR. GORDON: We don't intend to. We're not going to try to explicate the theory or to develop measuring instruments.

Let me give you a definition of the theory we would like developed. The theory of instruction specifies the relationships between events and conditions which occur in the school and change pupil behavior. We say that at the present time instructional theory may be expected to represent a *qualitative* impetus. Ultimately a theory should be constructed in terms of *quantitative* relationships among variables.

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CHAPTER VI.

Toward a Theory of Guided Learning in Development[1]

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Guiding the learning of the young is a problematic business. It is necessary, of course, in order for the young to achieve the abilities, skills, and those values in conduct required for participation in any culture. Yet men have always disagreed about what should be learned and how it should be taught. Moreover, the accuracy of any existing theory of the learning process is still highly dubious when it is called upon to provide guidance for the learning of the young. Any improvement in the accuracy of theory is to be welcomed.

Learning is ubiquitous in life. Considered broadly as effects of experience or as the modifications of the behavior of organisms in specified situations from encounters with environmental circumstances, learning appears to be involved even in the acquisition of patterns of activity once considered instinctive. For instance, calves and kids have for centuries been induced to give up suckling and going to their mothers to gratify hunger simply by being coaxed to drink from a pail and by being kept separated from their mothers from 10 to 14 days. The theoretical import of such husbandry concerning the importance of use on a sensorimotor pattern was largely missed, however, until Spalding (1873) observed the effects of disuse on flying in birds, and, later, when Shephard and Breed (1913) and Cruze (1935) found that limiting the use of pecking in chicks preserved an inaccuracy in the striking and also produced imperfections in the coordination of striking at a grain with seizing it and with swallowing it. In addition, Padilla (1935) reported that keeping newly hatched chicks from pecking for eight consecutive days or longer resulted in a complete loss of the inclination to peck. In the same vein, Birch (1956) has reported that preventing female rats from licking their genitals by keeping collars on their necks from weaning to parturition, results in failure to

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develop proper maternal behavior. Instead of licking their young and nestling them, rats so treated eat them. However, female rats provided with no materials to carry or play with while young later failed as nest builders (Riess, 1954).

The importance of experience or learning in development appears to increase up the phylogenetic scale. In those older studies of the embryology of behavior on such amphibians as amblystoma and frogs (Carmichael, 1926, 1927, 1928; Coghill, 1929), variations in environmental encounters had little influence on the perfection of such later behavioral patterns as swimming, but Kuo (1932a, 1932b) observed clear evidence of such influence in the embryologic development of birds. Similarly, the effects of the experiential deficit associated with cage-rearing as contrasted with pet-rearing, appear, at least suggestively, to be less in rats (Hebb, 1947) than in dogs (Thompson & Heron, 1954). Moreover, the duration of contact of infants with their mothers or mother surrogates required to produce following and separation distress increases from a matter of three or four hours in geese (Heinroth, 1910; Lorenz, 1935), to a matter of three or four days in such ungulates as the sheep, the deer, and the buffalo (see Thorpe, 1956, p. 397), to a matter of approximately 10 days in monkeys, to something like six weeks in chimpanzees (Harlow, personal communication), and to some five or six months in human children (Freud & Burlingame, 1944). Finally, the unmodifiability with experience of eye-limb coordinations reversed by surgical rotation of the eye in such lowly organisms as the amphibia (Sperry, 1951) contrasts sharply with the high modifiability of eye-hand coordinations reversed by means of lens systems in human beings (Ewert, 1930; Held & Hein, 1958; Stratton, 1897). At least two factors appear to be of signal import in the increasing role of experience up the phylogenetic scale. One factor is a decrease in the dominance of the predetermination of morphological and behavioral development. With this goes a decrease in regenerative capacity. This decrease ranges from the capacity of parts of worms to regenerate whole worms, to the crayfish to regenerate claws that have been amputated, down to mere healing of wounds in mammals. A second factor is an increase in the proportion of the brain not directly connected with either receptor inputs or motor outlets over the proportion of the brain which does have such direct peripheral connections. This Hebb (1949) has termed the A/S ratio, but it might better be called the Intrinsic/Extrinsic ratio after Rose and Woolsey (1949). With the decrease in chemical control of maturation goes the development of such arrangements as the egg shell in birds and the uterus in mammals to standardize the environment of the embryo during its most rapid phases of epigenetic maturation. With the increase in Intrinsic/Extrinsic ratio goes a prolongation of the period of infant dependency upon maternal or familial care.

In the evolution of human culture, providing the learning of the very young was apparently left largely to the intuitive wisdom of mothers (Briffault, 1927) and perhaps later to mothers and fathers. The earliest institutional care appears to have been concerned with training and testing adolescents for their roles of adults (van Gennep, 1909). About as soon as communication with writing became a part of culture, however, schools were developed as an institutional supplement to parental guidance of the learning during late infancy and childhood. Moreover, Plato (*Laws*, Bk. 7) discussed the importance of experience in early infancy, and even before birth, very long before such experience was taken seriously by most men.[2]

Many of the goals of the teaching of the young have varied from culture to culture, from age to age. Sumner (1906) was convinced that learning, as manifested socially in the mores, "can make anything right and prevent condemnation of anything"; yet Sumner saw little hope of improving the lot of mankind with deliberate control of education. Today one must question his pessimism. The thrust of what Mannheim (1936) termed the "sociology of knowledge," beginning perhaps with Francis Bacon's (1620) hope that science could one day correct the chronic errors of the "idols of the tribe," has shown that the problems of each civilized age have governed, at least in part, the topical direction of investigation, the nature of logical structures created, and the challenges posed for social change (see Hunt, 1952). The burgeoning technology of our day has markedly decreased the demand for those people with "strong backs and weak minds." At the same time, it has greatly increased the demand for those who can solve problems with the use of linguistic and mathematical symbol systems. This burgeoning technology has thereby established and fixed some of the goals of learning in the young. They must master these symbol systems, for no individual without considerable literacy and considerable skill with numbers can participate meaningfully in our culture. Moreover, the higher the level of skill with these symbol systems, the more meaningful becomes the individual's participation.

Such a goal for learning in the young calls for nothing less than an increase in the general level of those symbolic skills which have been subsumed under the term intelligence. Elsewhere (Hunt, 1961), I have argued that no system of education has ever maximized the genotypic potential of the young for intellectual development. The question is how best to guide their learning in such a fashion as to make the learning of these symbol systems interesting and to foster initiative and inventiveness in their use. This question calls for a more adequate theory of guiding learning than now exists.

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[2] For calling this very interesting reference to my attention, I am indebted to Mr. Richard Kobler of the Thomas A. Edison Laboratory.

The traditional conception of learning is based almost completely on the ways it has been investigated experimentally. Thus, learning has meant rote learning, the effect of practice on skills, classical conditioning, and instrumental learning or operant conditioning. In every one of these types, a sensorimotor (S-R) connection between receptor input and motor output is envisaged.

Investigation of rote learning began with Ebbinghaus's (1885) classic studies of memory for nonsense syllables, words, and verbal passages after various numbers of readings. In the schools, rote learning is as old as the schools themselves, in either the west or in China. Investigation of the effects of practice on skills began with the studies of Bryan and Harter (1897) on learning telegraphy. Traditionally, practice has been viewed as the essential factor for mastery of such skills as playing the piano. Investigation of classical conditioning began in 1899 when Pavlov (see 1927) observed during his Nobel-prize-winning work on digestion that dogs will salivate at the mere sight of food or even at the sound of events leading to the appearance of food. Some years later, Bekhterev (1913) reported his classic work on the conditioning of defensive reflexes wherein animals withdraw from inputs that have anticipated encounters with painful stimulation. In many ways, classical conditioning is but a behavioral version of the ancient principles of association: at least as old as Aristotle. Moreover, in his theories of psychological development, Watson (1914, 1919) made conditioning the prototype of all learning. The investigation of instrumental learning began in William James' basement with E. L. Thorndike's studies of the attempts of various birds and mammals to solve problems of the maze and the puzzle-box. Thorndike appears to have accepted C. Lloyd Morgan's (1894) critique of Romanes' (1883a) notion of animal intelligence, and he borrowed Morgan's description of the process of solution in the term "trial-and-error." Moreover, Thorndike introduced the notion of reinforcement in his "law of effect." It was precisely because the response made by the animal-subject was "instrumental" to his gratifying some need that this kind of encounter came to be called "instrumental learning." It was Skinner (1938, 1953a, b), however, who divided all the presumably unlearned responses of organisms into "respondents" — evoked by specific receptor inputs — and "operants" — coming spontaneously from the organism; who labeled such learning "Type-R" or "operant conditioning," and who put "operant conditioning" at the theoretical center of all major effects of experience important for education (Skinner, 1954) and socialization (Skinner, 1948).

In considering these kinds of learning traditionally investigated, it is important to distinguish the experiences inducing learning from the consequent changes in behavior that give evidence of learning. The nature of the various kinds of inducing experiences and their consequences for these traditional kinds of learning may be identified as follows: for rote learning, the experience of repeated rehearsals of a given set of verbal materials has the consequence of their memorization: the ability to repeat them. For skill learning, the experience of "practice" or the mere repetition of a given kind of activity has been seen "to make perfect" the behavioral skill repeated. For classical conditioning, the experience of repeated encounters with an originally ineffective receptor input (the CS) which is followed by another receptor input (the US) that regularly evokes some given activity (the R) has been seen as the basis for the consequent stimulus substitution wherein the CS comes to evoke the R without the intervention of the US. For instrumental learning or "operant conditioning," the experience inducing learning follows the activity which serves to bring about this experience. This experience is termed "reinforcement." The consequences that show learning are (1) response selection, i.e., the tendency for the response reinforced in any situation to dominate all others as in the case of the successful modes of escape from Thorndike's (1913b) problem boxes; and (2) response strength, measured sometimes in terms of latency, or reaction time, sometimes (especially by Skinner and his followers) in terms of response rate, and sometimes in terms of the number of responses required to extinguish responding. In the work of Skinner, both response rate and number of responses required for extinction have been found to vary greatly with the schedules of reinforcement (Ferster & Skinner, 1957). The conceptions of the nature of reinforcement in the theory of "instrumental learning" and in the theory of "operant conditioning" differ radically. In the case of "instrumental learning," the reinforcement is presumed to reside in the capacity of the activity or response concerned to reduce a drive (Hull, 1943) or to provide satisfaction (Tolman, 1938; Tolman, Hall, & Bretnall, 1932). In the case of "operant conditioning," anything that serves empirically to strengthen the response is accepted as a reinforcer (Skinner, 1958a); its broader impact on the organism Skinner (1950) has considered to be irrelevant. The chief point is temporal; the reinforcement follows the action and, after the thought model of natural selection, determines the fate of such actions.

Although these kinds of learning traditionally investigated are regularly discussed in courses in educational psychology and have some impact on educational practice, they have hardly provided the basis for a highly efficient approach to teaching that fills the young with joy in learning. While the principles of rote learning may have provided a few aids for such things as learning to spell, they have failed to show how to motivate the young, and they have failed to foster that skill in solving problems with our symbol systems that is traditionally called ability to think. From the investigations of practice has come the useful principle that the learner should be given knowledge of his results, but how much more? Classical conditioning has provided hypotheses about the origin of anxieties and fears that help explain some of the symptoms of neuroses and psychoses, but it has not provided a theory for guiding the education of the young. Operant conditioning has provided empirical results of considerable promise. It has recently promised to become a powerful method of producing therapeutic changes in those with behavior disorders (see Krasner & Ullman, 1965). Moreover, it has provided the background for one approach to programmed learning (Skinner, 1954, 1958b; Skinner & Holland, 1958). Yet, ironically, in view of Skinner's (1950) avowed disregard for theory, his scheme leaves out of account a variety of antecedent experiences with their consequences in behavoir and, also, their implicit consequences in central processes, unless one joins Skinner's band with a will to force the nature of these into the mold of Skinner's rubrics. Bijou and Baer (1961, 1965) have made an interesting attempt to write an account of child development in the terms of classical and operant conditioning. While they and their colleagues have been exceedingly ingenious in the invention of adapting operant procedures to work with children, I remain quite unconvinced that they provide an adequate theoretical basis for guiding the learning of the young entirely in these terms. The principles of operant conditioning will undoubtedly prove highly useful in modifying behavior and perhaps especially useful in the development of what White (1959) has termed "competence motivation," but other principles will be needed for the development of intellectual operations, for the construction of reality, and for understanding how organisms work in achieving these.

Other Kinds of Experience with their Consequences

A relatively wide variety of other kinds of experience with other kinds of consequences in both behavioral and neuroanatomical structure have at least been identified, even if they have not been extensively investigated. No attempt will be made here to present a complete catalog of these, but clarity demands the description of some. Moreover, the fact that no taxonomy of these other forms of learning exists, to my knowledge, indicates the relatively primitive state of our knowledge of them for the guiding purpose. The various illustrations to follow are arranged roughly according to the order in which I suspect they are manifest in the course of the developmental epigenesis of an infant mammal's interaction with his circumstances.

(1) *Input Habituation.* The experience of continuous or repeated encounters with receptor input of fixed characteristics has the consequence of extinguishing the arousal and attention which ordinarily accompany such inputs. This consequence of such experience is nicely illustrated in a

study by Sharpless and Jasper (1956). With needle electrodes implanted within the brain-stem reticular formation of a cat, these investigators presented repeatedly a fairly loud sound lasting for about three minutes. At first, each presentation evoked a burst of regular, high-frequency EEG waves of low magnitude like those typically found in anxiety or great effort. With the successive presentations, the duration of such EEG arousal reaction decreased. After some 30 presentations, this arousal reaction had disappeared. As this same experiment was repeated day after day, the arousal reaction to the loud sounds recovered at the beginning of each successive day, but they made their disappearance with fewer and fewer presentations. Following this receptor habituation, however, any change in any characteristic of the sound stimulus served to reinstate the EEG evidences of arousal. Decreases in loudness were as effective in restoring the arousal reaction as increases in loudness. Moreover, changes in pitch were as effective as changes in loudness.

Such receptor habituation has been shown repeatedly in the work of Russian investigators on the "orienting response" (see Razran, 1961; Simon, 1957). The "orienting response" consists of a combination of arousal (as evidenced by such traditional physiological indicators of emotion as the vascular response — plethysmograph, the galvanic skin response — GSR, and the electroencephalogram — EEG) and attention (as evidenced by movements calculated to orient the receptors for better input). This "orienting response" is evoked by changes in the various characteristics of on-going receptor input. As these changes occur over and over, they gradually lose their capacity to evoke arousal and attention, but a new change in the characteristic of the input will again evoke the "orienting response." William James (1890) was quite familiar with this phenomenon; he illustrated it with the observation that one does not hear the ticking of the clock until it stops. This "orienting response" represents what I have elsewhere considered to be the most primitive form of motivation inherent in an organism's informational interaction with circumstances (Hunt, 1963a, 1965b).

One might possibly include the "orienting response" within Skinner's category of respondents, but the inclusion demands some forcing to fit the mold, because minimal skeletal action is involved and because the response disappears with repeated encounters with the unconditioned stimulus. In passing, it may be worth remarking that the empirical successes and failures to obtain what was called "latent learning" (see Hilgard, 1956, pp. 211-214) may well have depended upon whether or not experimental procedures employed changes in receptor inputs that evoked the "orienting response."

(2) *Sequential Organizations.* The experience of encountering a se-

quence of changes in receptor inputs has as its consequence sequential organizations of central processes. In the language of common sense, these sequential organizations manifest themselves as expectations, but they imply something akin to what Hebb (1949) has called "phase sequences." Such sequential organizations are implied very early in the behavior of infants. The yummering of the freshly awakened infant stops with the sound of footsteps. So long as those footsteps increase in loudness, all is well, but if they begin to decrease in loudness or if the accustomed increase in illumination that comes with turning on the light fails to occur, the crying is resumed. Often it is resumed with increased loudness. Within the laboratory, this phenomena of sequential organization is illustrated in Humphrey's (1939) classic study of verbal expectation wherein the subjects were asked to guess whether or not the appearance of one light would be followed by the other light through various conditions of contingency. When the second light invariably followed the first, the subjects gradually came to guess that the appearance of the first light would be followed by the second, as their experience had indicated. When the second light was turned on only in random alternation, the subjects guessed at the chance level. The fact that encountering changes of input early in a previously experienced series leads to behavior anticipatory of the succeeding events derives from the fact that the central processes run off more rapidly than do actual events.

Such sequential organizations would appear to account for what Piaget (1936) has observed as the coordination of looking and listening wherein "something heard becomes something to look at." The classical conditioned response is a special case of sequential organization, but it occurs between receptor inputs and motor outputs. Here we have evidence of a sequential organization of the traces of receptor inputs only. These may be seen as sequential stimulus-stimulus (S-S) relationships in the place of the stimulus-response (S-R) relationships of classical conditioning. It may well be that both S-S and S-R sequential organizations will ultimately be found to be based upon temporal relationships among the central processes evoked by receptor inputs. Would it be possible to establish S-R sequences at all, for instance, with sensory feedback from the motor response prevented from reaching the brain under conditions where mere conditioned arousal itself would be highly unlikely to account for the motor response?

(3) *Recognitive Attraction.* The experience of encountering repeatedly a pattern of receptor inputs has the consequence of perceptual recognition, and this recognitive familiarity appears to provide, under conditions still not well understood, a basis for attractiveness, cathexis, or emotional attachment. This motivational quality of recognitive familiarity I would

like tentatively to call "recognitive attraction." Evidence for such attraction appears in the investigations of the phenomenon which Lorenz (1935) has termed "imprinting." Lorenz and others observed that newly hatched birds will follow a moving object after the object has attracted their attention a number of times, and henceforth the chick will show its attachment to the object by following it and by moving to it rather than others. Usually the object is the mother bird and imprinting a basis for survival.

Interpretations of the basis for such attachments vary. Although Hess (1959) has emphasized the role of the effort of following in the strength of imprinting as measured in various later choice situations, both Collias (1962) and Fabricius and Boyd (1952-1953) have pointed out that the following begins in the original imprinting situation only after the young bird has sat in a roosting posture for a period of time during which its attention is repeatedly attracted by the change in ongoing receptor input offered by the moving and clucking decoy. Moreover, merely exposing the young bird to the sight and sound of the decoy while preventing it from following sufficed to produce vigorous following at a later time (see James, 1959; Jaynes, 1958; Moltz, 1960). Also, Campbell and Pickleman (1961) have reported that imprinted objects later have reward value in maze learning.

In human beings, I have gleaned from Piaget's (1936) observations of his own three children that it is commonly repeatedly-encountered objects that children try to hold within perceptual range (Hunt, 1963a). In an exploratory test of this hypothesis, my colleague, Dr. Uzgiris, has found that infants two months of age will look longer at a pattern which has been hanging over the crib for a month than they will look at an unfamiliar pattern of relatively similar character (Uzgiris & Hunt, 1965).

Thorpe (1959) has suggested that birds learn their songs by a process of auditory imprinting. Parallel with this in human beings, it is interesting that Piaget (1936) observed that human infants imitate first only patterns of vocalization already in their repertoire. It may well be that recognitive attraction is the motivational basis for such autogenous activities as the repetitive babbling and hand watching so commonly observed in infants during their fifth and sixth months (Hunt, 1965b). Recognitive attraction is a hypothesis calling for investigation.

(4) *Image Formation*. The experience of repeated encounters with objects, persons, and scenes from a variety of vantage points culminates in behavior implying central processes which can represent those objects, persons, and scenes with increasing degrees of permanence. Even the neonate can follow an object visually if it is placed at a distance from his eyes proper for his limited range of visual accommodation (Haynes, White, & Held, 1965). Once the object escapes his view, the infant's eyes

immediately leave the point at which it escaped: out of sight, the object is truly out of mind. Later, the game of peek-a-boo becomes possible, but only when the human face has acquired such a degree of permanence that the infant is motivated to look at the place where it disappeared and to keep looking for its return. Still later, with more such encounters, children will attempt to search with their hands for objects which have disappeared. Even later, they will follow them through a series of displacements, and then through a series of hidden displacements, at which point the child can be said to have genuine imagery. Such phenomena as color constancy and size constancy appear to develop in a large part with increasing solidity and stabilization in the representative central processes we have traditionally called imagery. Similarly, illusions deriving from the dominance of perceptual cues over conceptual generalizations mediated by central processes appear to decrease with age, while those illusions deriving from the dominance of conceptions over perceptions tend to increase with the age (see Piaget & Lambercier, 1943a, 1943b; Piaget, Lambercier, Boesch, & Albertini, 1942).

(5) *Perceptual Learning Sets.* The experience of learning to recognize a wide variety of different objects, persons, and scenes probably leads to a rough equivalent of what Harlow (1949) has called a "learning set." In Harlow's now classic work, monkeys learned to pick out the location of grapes from the shape of the figure on the cover on the cup. At first such discriminations took many trials. Monkeys tend to look for lures in the position where they last found them. Harlow's procedure associated the reward ambiguously with the place cue, and regularly and unambiguously with the cover cue. Under this procedure, the monkeys gradually relinquished their use of the place cue in favor of the cover cue. In the course of solving a long series of such problems, the monkey "learns to learn," or at least to solve this kind of problem. This is the "learning set."

Something analogous to learning sets appears to be manifest in a great many situations in the course of psychological development. Perhaps the first of these consists in solving the recognition problem with a large variety of objects, persons, and scenes. In the course of coming to recognize a variety of these, the infant appears gradually to achieve a generalized expectation that receptor inputs should make sense as objects, persons, and scenes — that they should be recognizable. Such a generalized expectation provides a kind of task for the infant, a kind of task that may well motivate what Woodworth (1947) characterized as the "trial-and-check process of perceiving." The goal of this process is clear perceptual meaning, and identification of the object or the person or the scene. Such a learning set may well be a factor in the older infant's persistent looking at unfamiliar objects. His apparent interest in the novel may well be in part a consequence of his learning-set task to recognize what for him is novel.

(6) *Intentionality and Competence*. Experiences of attempting successfully to maintain or regain perceptual contact with objects, persons, and places that have become recognitively attractive appear, from Piaget's (1936) observations, to have the consequence of producing intentions, or intrinsically motivated plans (Hunt, 1963a, 1965b). In the earliest form, intentions appear merely to be actions responsive to the loss of perceptual contact with a spectacle that has been made interesting by recognitive attraction or by association with homeostatic gratification. Under the natural conditions in which Piaget (1936) observed his own children, it would appear that the infant discovers "operant conditioning" through his effort to hold on to or regain perceptual contact with what has become recognitively attractive. Success at such efforts in a variety of settings probably leads gradually to another kind of learning set, a kind of rule for action which has motivational import. Functionally this learning set appears to have the nature of a rule that may be verbalized as: "if I do things, I can make interesting things happen." In this generalized functional form, goals appear to become differentiated from actions, and the infant appears to anticipate the consequences of his actions. Anyone who has ever dandled an infant on his knee must have noted the anticipatory character of action that betokens intentionality. If the dandler stops his motion, the infant takes it up. When the dandler resumes his motion, the infant stops his own. In this situation, it is hard to avoid the impression that the infant anticipates the goal of resumed motion by the dandler.

Operant conditioning has seldom been observed during the early months of infancy. (Lipsitt, 1963) and Piaget (1936) did not observe even the beginnings of the "secondary circular reactions . . . centered on a result produced in the external environment" that herald intentionality until the third stage, which he saw as beginning when his children were in their fifth month. Yet it is very likely that arranging proper timing of contingencies of the various acts that an infant makes fairly regularly with perceived events of interest to him, can induce such S-R connections much earlier. A suggestive example in which the infant's act was to stop squirming occurred recently. I had occasion to be holding a somewhat fussy infant then in his seventh week. I held him on my shoulder, face to me, in the burping position. Years ago with my own children, I had learned that singing with rhythmic patting of an infant's back will often stop fussy squirming and yummering. It did in this case. When I stopped singing and patting, this infant shortly resumed his squirming and yummering. It turned out that the patting was more important than the singing which, at the behest of others in the company, was dropped. At first, the delay between my ceasing to pat him and his resumption of squirming and yummering was of the order of 15 or 16 seconds, as measured by counting 1001, 1002, etc. With successive trials, this delay decreased. On the sixth trial it was about eight seconds. On the seventh trial it had increased beyond 15 seconds, and on Trial 8, the infant had gone to sleep. Some five days later, I had another occasion to hold this infant. Although he was less fussy than he had been on the first occasion, he again squirmed and sometimes yummered softly when I stopped the rhythmic patting. On this later occasion, the first delay was of the order of 10 seconds, and the delays decreased to the order of 3 seconds in some half-dozen trials. The quality of interested anticipation, found in the dandling situation with older infants, was absent in this infant's squirming, but the decreasing delay in resumption of squirming and yummering suggests learning even at this early age of two months.

The consequences of such experiences call for investigation. It appears very likely that the effects of such experiences will transfer cumulatively from one to another. One wonders if repetitions of such experiences will not lead fairly shortly to the learning set that betokens intentionality. Subsequently, it seems altogether likely to me, the fate of such intentional activities would be highly important in producing apathy or initiative. What White (1959) has termed "competence motivation" may be strongly influenced by "schedules of reinforcement" (Ferster & Skinner, 1957) for such intentional activities. From the investigations of the effects of intermittent reinforcement on resistance to extinction (Humphreys, 1939; Jenkins & Stanley, 1950), one would guess that persistent or courageous competence motivation probably derives from experiences with success intermixed with an increasing proportion of failures and from successful experiences won only at the expense of prolonged effort.

Although learning from experience with the consequences of action is certainly no new principle, the notion that the effects of such experiences may fall as much as, or perhaps more, within the domain of motivational rules for action as within the domain of information-processing for decisions; and the notion that such experiences may have cumulative motivational effects that culminate in intentions and "competence motivation" (see Hunt, 1963b, 1965a) are hypotheses suggesting kinds of investigation hardly envisaged in the traditional work on operant conditioning.

(7) *Interest in the Novel and the More Complex.* Experience with familiar objects, persons, and scenes leads to an interest in what is novel and what is more complex than that which has become familiar. This interest comes in the human infant during the latter part of the first year (Piaget, 1936), but it appears to follow what is at first, if we are not mistaken (Uzgiris & Hunt, 1965; Hunt & Uzgiris, 1966), a preference for what is recognitively familiar. Much remains to be learned about this

transformation, but by combination one gleans, from the various kinds of evidence of the interest in the novel on the part of a variety of mammals from the rat to man (see Berlyne, 1960) and from the evidence of fear of the strange and too incongruous (Hebb, 1946), that an optimum of discrepancy or incongruity comes to exist for each organism between the information which has become for him boringly familiar and that in which he can be interested (see Hunt, 1963b, 1965b). When an infant shifts from trying to retain the recognitively familiar within his view to an apparent preference for and longer looking at that which is novel, the transformation may have two sources. One source may reside in the rule for perceptual encounters that "things should be recognizable." Failure to recognize may have gradually become a source of frustration that motivates persistent looking. A second source may reside in the tendency for the repeatedly encountered to become boring (Bexton, Heron, & Scott, 1954; Hebb, 1949). When the experience concerned involves chiefly such characteristics of receptor inputs as intensity, hue of light, pitch of tone, etc., recent encounter appears to be very important in determining the adaptation level (Helson, 1964) which supplies the standard with which new inputs are compared (Haber, 1958; McClelland, et al., 1953). Increments and decrements of such stimulus dimensions, within the context specified, are apparently equal sources of relief from boredom as judged by their reinforcement value (McCall, in press; 1965). On the other hand, when complexity is involved, the interest appears to be directed regularly toward the more complex (Dember, Earl, & Paradise, 1957), and recent experience with any given level of complexity serves only to diminish interest in it and levels below it except, possibly, when anxiety or fatigue interferes (Unikel, 1966). Whenever a given level of complexity within any given domain has been "mastered," interest appears to turn always toward the more complex within that domain. Thus, motivational basis for change in cognitive or informational structures appears to be built into the systems for processing information within each organism or person.

(8) *The Apparent Ubiquity of Learning Sets in Psychological Development.* The experience of encountering the same general kind of problem repeatedly in a variety of situations appears to culminate in a variety of learning sets. Some are manifest as rules for action with chiefly motivational import, and some are manifest as rules for the way things are to be found in reality with import chiefly of informational or cognitive import. Of the former, I have already mentioned the still hypothetical active sets that "things should be recognizable" and that "if I do something, I can make interesting things happen." Of the latter, I have mentioned how the cumulative effect of encountering repeatedly objects, persons, and scenes culminates in an increasing permanence of those central

processes that represent objects. Many learning sets appear to have combinations of import for both motivation and information processing. Some of the clearest examples appear in the acquisition of language. After infants have developed a number of pseudo-words which stand symbolically for imaginal congeries (Hunt, 1961, p. 175ff), they commonly begin to ask repeatedly with each novel object encountered, "What's that?" (see McCarthy, 1954). This question seems to imply that the child has gleaned the rule that "things have names." With the appearance of this question, vocabulary growth rises sharply. Inasmuch as the appearance of "What's that?" comes only after a variety of pseudo-words have been acquired, the relationship fits nicely the paradigm of the learning set. Later, another such set appears. It is marked by the question, "Is it a this or a that?" This question appears to imply that the infant has gleaned the rule that things come in sets or classes. Still later come the "why" questions, investigated by Nathan Isaacs (1930). These appear to imply at least a primitive form of the notion or rule that events and things have causes. The concrete operations of thought — which presumably underlie the conservation of quantity or distance, weight, and volume, the capacity for seriation, and the formal, logical operations required in thought for the solving of various kinds of problems calling for the hypothetico-deductive method (Inhelder & Piaget, 1955; Piaget, 1947) — would all appear to be special examples of such learning sets. Evidence for this assertion comes from at least two sources. In the case of the conservation of quantity, weight, and volume, Piaget and Inhelder (1940) have found an ordinal relationship: any child who can conserve volume will conserve weight and quantity also, while a child who conserves weight may not conserve volume but will always conserve quantity. Uzgiris (1964) has found, however, that an occasional child may conserve volume with one kind of material but with another kind of material fail to conserve weight and conserve only quantity. Fairly commonly, children may conserve weight with one kind of material but conserve only quantity with another. While Uzgiris found no instances in which a child who conserved weight would fail to conserve quantity with a given kind of material, generality across materials comes but gradually. Evidence of a similar sort appears in Smedslund's (1964) splendid study of the development of concrete reasoning.

(9) *Disconfirmation and the Constructions of Reality.* Experiences of encountering information that disconfirms existing beliefs about reality produce changes in those beliefs or conceptions.

Evidence of the capacity of encounters with disconfirming information to produce directly changes in belief and conception comes from a variety of sources. One of these is the social psychological studies of attitude organization and change (Rosenberg et al., 1960). In these studies the ready-made attitudes or beliefs of the subjects about a given topic are measured. A message is then given to the subjects. Following the message, other measures of attitude of belief on the same topic are again measured. The changes are manifest in the differences between the first and second measures of belief. Moreover, these changes grow or diminish with time as a function of various relationships between information input and beliefs (Ewing, 1942). A second source is the evidence assembled by Festinger (1957) for his theory of cognitive dissonance. Many of these studies are like those of attitude change: merely encountering information dissonant with beliefs held, if the validity of the information cannot be impeached, results in modification of the beliefs held. Furthermore, whenever human subjects are known to hold dissonant beliefs simultaneously, merely encountering situations where the dissonant beliefs are brought into play results in modification of one to reduce the dissonance. A third source of such evidence may be found in the investigations aiming to hasten the acquisition of concrete operations (Piaget, 1945) in young children. Those methods which have served to focus the child's attention on the discrepancy of observed phenomena from his asserted beliefs have appeared quite regularly to be more effective than either primary or secondary reinforcement for proper responses or statements (Brison, 1965; Bruner, 1965; Gruen, 1964; Smedslund, 1960, 1961a, 1961b). A fourth source is Suchman's (1961) inquiry training. With 10-year-olds Suchman has utilized the presentation of the phenomena of eighteenth-century physics and chemistry which surprise children as a method of eliciting their interest. The phenomena used include, e.g., the collapsing varnish can and the Cartesian diver. The children's interest prompts them to ask questions. By demanding questions that can be answered only by *yes* or *no*, Suchman puts the children into a situation where they gradually learn (1) to plan sequences of questions which yield cumulative information by means of which they can construct theoretical conceptions that fit reality, and (2) the process that men of science have always followed when they have encountered observations that failed to fit their ready-made conceptional schemes.

Such evidence quite clearly implies that encounters with information which disconfirms conceptions ready-made at any given time directly force changes in those conceptions. The change in conception follows directly the encounter with the disconfirming information. It is not a matter of the consequences which follow actions, although the skill in planning questions in Suchman's experiments does fit the temporal paradigm of operant conditioning. This principle of change with disconfirmation apparently operates whether the constructions of reality are called, in traditional terminology, attitudes, beliefs, conceptions, expectations, images, hypotheses or, in less traditional terminology, "operational structures of thought" (Piaget, 1947). In any case, these constructions of reality presumably have a neurophysiological basis in semi-autonomous central processes representing reality (Hebb, 1949). These representative semi-autonomous central processes constituting what has traditionally been called thought grow and change when they encounter coded inputs incongruous with the already coded structures in the storage of the brain.

One can readily argue that, even under the temporal conditions of instrumental learning or operant conditioning wherein frustration is presumed to weaken unsuccessful responses and reward is presumed to strengthen the successful ones, the actual roles of frustration and reward are merely to give motivational emphasis to the disconfirmation of certain organizations of central processes and the confirmation of others. Presumably it is such organizations of central process that mediate overt behavior, perception, and the problem-solving with symbols so important in our technological culture. Tolman (1932, 1952) repeatedly argued for such an interpretation of the learning process. I now believe he was essentially correct.

(10) *Receptor Function and the Semi-autonomous Central Processes.* Experiences involving chiefly receptor function are more important than heretofore believed in the development of those organizations of central processes mediating behavior, perception, and thought. In one sense, this statement is a corollary of proposition No. 9. The evidence supporting it, however, comes from the physiological laboratory rather than from social psychology, and this evidence demonstrates quite clearly that there are genuine neuroanatomical and neurochemical consequences of experiences involving chiefly receptor function.

Much of this evidence had its conceptual origin in the theorizing of Hebb (1949). Hebb's hypothesis that the development of form-vision derives from sensory (S-S) integrations based on the contiguity principle was originally suggested to him by von Senden's (1932) assemblage of cases of congenital cataract wherein the surgical intervention that recovered vision failed to bring about visual recognition of highly familiar objects without extensive visual experience with these objects. This hypothesis prompted Riesen and his colleagues to rear chimpanzees in the dark in order to determine the effects of light stimulation on the function and the structure of the visual system. A period of 16 or 18 months in total darkness produced drastic defects in infant chimpanzees. On the functional side, these defects included absence of the blink to a threatened blow to the face, failure to develop visual accommodation upon which the blink depends, absence of visual fixation and pursuit of objects, absence of recognition of even the highly familiar feeding-bottle until it was touched, partial loss of pupillary reflexes, and failure to develop fear of strange objects and persons. Although some of these perceptual defects improved to a limited degree with continued exposure to full daylight, they proved to be essentially irreversible in chimpanzees submitted to total darkness for 16 months or longer. On the structural side, the defect was manifest in life as a pallor of the optic disc. In histological examination following autopsy after some six years in full daylight, changes in the ganglion-cell layer of the retina and in the optic nerve were still quite evident (see Riesen, 1958). In other words, the anatomical consequences were irreversible.

Even periods of no longer than seven months, wherein infant chimpanzees were deprived only of pattern vision and not of light, resulted in perceptual deficits. These deficits included failure to develop the blink reflex, absence of visual fixation and pursuit, absence of recognition, and failure to develop a fear of that which was strange. With this shorter period of deprivation involving only pattern vision, however, these changes were reversible. The young chimps acquired the ability to follow objects and to fixate a person visually within two or three weeks of daylight vision. Recognition of a feeding-bottle approaching the mouth came within three or four weeks. Fear of strange objects developed within about six weeks, and fear of unfamiliar persons developed in about 25 weeks. In other words, it took nearly as long, following exposure to life in daylight, to develop these various perceptual abilities in those infants which had been deprived of pattern vision for seven months as it does to develop those same abilities in a new-born chimpanzee.

Evidence of defects in both peripheral and central neural structures following deprivation of perceptual experience has come from another source. This other line of investigation stemmed from Hyden's (see 1960) biochemical hypothesis that the metabolism of ribonucleic acid (RNA) in the interactive relationship between neural and glial cells of the retina and brain is highly important in learning. The hypothesis prompted Brattgard (1952), one of Hyden's students, to rear rabbits in the dark. Histochemical analyses of the retina of these dark-reared rabbits revealed a deficiency in RNA production of the retinal ganglion cells. Such histological and histochemical effects of dark-rearing have now been found not only in rabbits (Brattgard, 1952) and in chimpanzees (Rash, Swift, Riesen, & Chow, 1961) but also in kittens (Weiskrantz, 1958) and even in the lowly rat (Liberman, 1962).

Conversely, evidence of increased growth of central structures following enrichments of experience has been repeatedly reported. Altman and Das (1964) have recently reported a higher rate of multiplication of glial cells in the cerebral cortexes of rats reared in "enriched environments" than in rats reared in "impoverished environments." In another extended program of investigation, led by Krech and Rosenzweig, rats reared in complex environments have shown cortical tissue greater in weight and thickness than that of rats reared in the simpler environments of laboratory cages. Here complexity has been defined in terms of the variety of objects perceived and manipulated, and the variety of different kinds of space to be explored. The rats reared in the complex environments have also shown histochemical effects in the form of higher total acetylcholinesterase activity of the cortex than the cage-reared rats (see Bennett, Diamond, Krech, & Rosensweig, 1964).

The findings from these various sources appear to indicate that Piaget's (1936) aphorism that "use is the element of a schema" is more than a metaphor. While these findings of the neuroanatomical, neurochemical, and neurophysiological effects of experience may not serve directly in a theory of guided learning, they indicate that the mediating central processes inferred from behavior are more than figments of imagination, that they are more than mere logical constructs.

Two other lines of investigation are filling in our picture of the connections between receptor function and the neuroanatomical and neurochemical effects of experience which mediate thought and action. Gibson and Walk (1956) have found that rats reared in the presence of circles and equilateral triangles were better form-discriminators than were rats without such early experience. Although several later studies served to call this finding into question (Gibson, et al., 1958), studies by Walk et al. (1958, 1959) indicated that the variation among the results of their experiments was a matter of whether or not the figures (circles and triangles) encountered by the young rats were cut-outs or merely figures painted on surfaces. Significant effects followed only encounters with cut-outs. Earlier, Attneave (1954) had suggested that the informational content of a figure is concentrated at its "angles or peaks of curvature." In his still earlier theorizing, Hebb (1949) had argued that an organism must have experience with angles and sharply defined edges in order to develop form recognition. When Forgus (1958a, 1958b) compared the discriminative ability of adult rats which had been reared in the presence of circles and closed triangles with other rats which had been reared with circles and open-angle triangles, he found evidence that openness at the angles is important for facility in later discrimination. Very recently Cool (1965) has found that rats reared in spherical cages without visual contact with angles of any kind and with visual encounters only with curved lines with fuzzy edges, are later very much inferior in ability to learn visual discriminations to animals reared in rectangular cages with ample encounters with sharply defined angles. Very interesting work by Hubel and Wiesel with a cat (1959) and with a spider monkey (1960) is beginning to show

how perceptions of lines and angles get recorded within the perceptive fields of the cortex. Using a technique of recording from single neurons with implanted micro-electrodes in the striate cortex of unrestrained cats (Hubel, 1959), these investigators have found that the special arrangement of the excitatory and inhibitory regions of the receptive field of the cortex differs in a variety of ways from the fields obtained from retinal ganglion cells. When a rectangular target was rotated toward the major axis of the animal's central visual field, electrical responses of the cortex were obtained. The pattern of responses from stimuli of differing orientation or from stimuli undergoing differing transitional movements could be identified in terms of the patterning of those electrical responses within the receptive cortical fields. Centers within the receptive cortical field were flanked by a region of effect (on or off) opposite to that of the adjacent center. Cumulative effects of repeated encounters with edges and angles, and with the movements of edges and angles, and of the exciting of central units resulting therefrom, are presumably a major source of the increased multiplication of glial cells and increased acetylcholinesterase activity and the thickening of the cortex observed by Krech, Rosensweig, and their collaborators (see Bennett et al. 1964). Such presumably also is the basis for the increase in RNA production in the cells of the cortex (Hyden & Egyhazi, 1962). These various findings appear to imply that experience via the distance receptors may be considerably more important than we have traditionally supposed for the development of the central processes that mediate both the intrinsic motivation and those intellectual processes so important in our highly technological culture. The fact that edges and angles provide a basis for abrupt changes in the intensity of illumination lends support to the argument that variety in perceptual encounters and increasing complexity of circumstances are important aspects of early experience (Fiske & Maddi, 1961; Hunt, 1961, 1963a). Such findings are not irrelevant to a theory of guiding learning in the young.

(11) *Interactions of Learning and Maturation*. Experience appears to hasten anatomic maturation.

Learning and maturation have long been regarded as separate polarities in development, the former resulting from experience and the latter predetermined by heredity. But just as there is an interaction between heredity and environment (Johannsen, 1909), learning interacts with maturation in the course of psychological development.

Deprivations of experience retard the rate of development. Perhaps the most dramatic illustration of such retardation derives from Dennis's (1960) observations of infants reared from birth in a Teheran orphanage. Of these infants, 60% were still not sitting up alone in their second year, and 85% were still not walking in their fourth year. Although various theories have been employed to account for the apathy and retardation associated with orphanage rearing, it is very interesting in the light of the just-mentioned effects of varied perceptual experience that the most characteristic aspect of a young infant's situation in the typical orphanage is homogeneity of auditory and visual input. This is the opposite of encountering variety of input.

Conversely, supplements of experience of various kinds appear to hasten development. Perhaps the most dramatic illustration of such hastening is to be found in the recent work of B. L. White and his collaborators. In a normative study of the development of visually directed reaching, White, Castle, and Held (1964) identified as landmarks the "fisted swiping at objects," which appeared on the average at about 65 days of age in the infants being reared in the Tewksbury State Hospital, and "top-level reaching," which appeared on the average of about 145 days. An effort at massive enrichment (consisting of 20 minutes of extra handling each day from day six through day 36, prone posture for 15 minutes after each of three of the daily feedings from day six through day 124, and a special stabile featuring highly contrasting colors and numerous forms against a dull white background suspended over the infants from day 37 through day 124) delayed the median age of "fisted swiping" by some five days (from day 65 to day 70) but hastened "top-level reaching" by 50 days (from day 145 to day 95). The delay in "fisted swiping" implied that the stabile may have been too complex and overbearing for the first weeks. Substitution, at the sides of the crib, of two white disks with red nipples in their centers for days 37-68, followed by the introduction of the stabile from day 68 to day 124, served to reduce the median age for the onset of "fisted swiping" by some two weeks (from day 70 to day 55) and to hasten even further the onset of "top-level reaching" by another two weeks (to day 80). Inasmuch as the slackening of visual attention which appeared during the last 12 days of this latter attempt at enrichment implies that the stabile, originally too complex at day 37, had ceased to be complex enough to be maximally interesting, it would appear likely that introducing the stabile earlier and following it with a mobile during those last three or four weeks might hasten the onset of "top-level reaching" even more.

White's findings clearly corroborate those of Skeels and Dye (1939). Prompted by a clinical surprise, the latter transferred 13 infants, with chronological ages ranging from seven to 30 months and with DQ's ranging from 36 to 89, from a state orphanage to an institution for the retarded. There the older and brighter girls on the ward became very much attached to the children, moved them about, and played with them throughout most of their waking hours. In the course of two years, every one of these 13 children showed a gain in DQ. The minimum gain was seven points. All but four showed gains over 20 points. The maximum was 58 points. Skeels and Dye had left 12 other infants, with ages ranging from 12 to 22 months and DQ's ranging from 50 to 103, in the orphanage. When these children were retested after periods of between 20 and 33 months, all but one showed a decrease in DQ, and the decreases in 10 of these children ranged between 18 and 45 points. Because of the firmly held belief in genetically predetermined rates of development, these highly suggestive findings met only derision at the time.

One may ask why the older studies did yield findings so consonant with the notion of predetermined development. One reason, already noted, resides in the fact that the subjects in many of these studies were lowly amphibia (Carmichael, 1926; Coghill, 1929). In amphibia, the regenerative capacity is considerably greater than that to be found in mammals, and the AS ratio is considerably lower than that to be found in mammals, and especially in man. Moreover, the early studies of the effects of practice on the development of various skills in human children failed to take into account the epigenetic character of development (see Gates & Taylor, 1925; Gesell & Thompson, 1929; Hilgard, 1933). They failed to take into account the fact that experiences quite other than stair-climbing may be more important for the age at which stair-climbing appears than is mere stair-climbing itself. And so it goes with the age of walking, the age at which tower-building appears, etc.

The newer evidence clearly indicates that experience can alter and induce maturation, even anatomic maturation. Baldwin (1955) has wisely given a substantial place to what he calls stimulus-induced maturation in psychological development.

These 11 illustrations of various kinds of consequences from various kinds of experience clearly imply to me that our accounts of learning, and especially our tendency to limit all learning to classical conditioning and operant conditioning, are inadequate and inappropriate. Moreover, any theory of guided learning based only on these traditional conceptions of learning can hardly be adequate.

"THE PROBLEM OF THE MATCH" IN GUIDED LEARNING

Any workable theory of guiding the learning of the young that attempts to transcend the gross limitations of classical conditioning and instrumental learning must take into account what I have elsewhere called "the problem of the match" (Hunt, 1961, p. 267ff). Traditional educators have long recognized this problem under the guise of what has been called "readiness." "Readiness" was conceived, however, as nothing but a predetermined stage of maturation, as a stage at which the anatomical wherewithal permits, with a minimum of practice, acquisition of academic skills. This traditional concept of readiness took no account of the interaction of learning with maturation or of the epigenetic nature of the development of children's informational interaction with their circumstances. In formulating the "problem of the match," I am taking very seriously both the notion of such an epigenesis and the notion that experience plays a very substantial role in psychological development. The classic example of guiding learning appears in Plato's *Meno*. There Plato has Socrates argue that "seeking and learning are in fact nothing but recollection." Plato's aim is to get support for his theory of the independent existence and external reality of conceptual constructs. Socrates leads one of Meno's slave-boys to accept the principle that the area of the square of a diagonal, or hypotenuse, is the sum of the squares of the opposite sides, merely by asking the boy questions. But Socrates is a bit sneaky: he leads the boy to make assertions and then confronts him with the discrepancy between the assertions and drawings of squares. Moreover it is Socrates, not the boy, who suggests that each square is cut in half by its diagonal. To drive home his argument that learning is nothing but recollection, Socrates remarks (*Meno*, 85d) that "at present these opinions, being newly aroused, have a dream-like quality. But if the same questions are put to him on many occasions in different ways, you can see that in the end he will have a knowledge on the subject as accurate as anybody's." Actually, Socrates has forced the slave-boy, little by little, to accept a conception. By repeatedly confronting the boy with evidence dissonant with his previously-accepted conceptions, Socrates forces him to develop—perhaps even to create—a new concept. In many ways, this episode might be considered a nice demonstration of Skinner's behavior-shaping, but this would neglect the fact that the behavior of the slave-boy changes little: He is simply induced to say "yes" and "no" by utilizing his arithmetic skill in response to Socrates' questions and to the nature of the square as it is pointed out by Socrates. It is this series of inputs which both interests and perplexes the lad and which forces a modification in his conceptual structure. Moreover, in spite of his theory of recollection, Plato shows here a recognition of the phenomenon which Harlow (1949) has called the "learning set," for it is only after the same questions are put to the slave-boy on many occasions in different ways that Plato expects him to have full and accurate knowledge of the principle.

In this illustration, no age is given for the slave-boy, although we know that he speaks Greek and can multiply and divide. The importance of these underlying skills goes unremarked, but we can rest assured that had Socrates begun with a child of three or four, he could not have obtained the evidence that "such seeking and learning are in fact nothing but recollection." For all his theory of the independent reality of conceptual constructs, Plato intuitively avoided such an absurdity as attempting his demonstration with a child of four or younger. Much later, Kant (1791) did present the view that such categories of reality as causality, motion, space, and time are ready-made in the human mind. It has been the merit of Piaget (1937), however, to show that these categories do not exist for the child until they are epigenetically constructed out of continuous informational interaction with his circumstances. As primitive forms of these constructions emerge from his conceptual encounters, new perceptions provide incongruities which gradually force upon the child what Piaget has termed "accommodative changes" in his conceptual structures. His conceptual structures become stable only when they enable the child to predict what he will perceive and to account for the incongruities among his perceptual impressions. It is presumably these stable conceptual structures for which there are readily translatable terms for denotable objects.

The "problem of the match" may be conceived as one of providing the child with circumstances related to his already-stored information and to his already-learned skills in such a way as to promote psychological development, in both intellectual and motivational aspects.

Intellectual Aspects of the "Problem of the Match"

The concept of intelligence as problem-solving capacity based upon a hierarchical organization of conceptions and of information-processing strategies has been emerging from such varied sources as the observations of intellectual development in children by Piaget (1936), the programming of electronic computers (see Newell, Shaw, & Simon, 1958), and studies of human problem-solving (see Gagne & Paradise, 1961). Each of the conceptual constructs and each of the information-processing strategies in the hierarchy resembles a "learning set"; each, moreover, appears to derive from having encountered and solved a series of problems of a general type. Gagne and Paradise (1961) have put the matter as follows:

> ". . . the theory of the learning-set hierarchy has a number of implications in the programming of productive learning. Chief among these is the idea of designing the frames of a program in such a way that they constitute an ordered sequence logically related to the hierarchy of learning sets for the desired final task, provide for recallability of subordinate learning sets, and furnish the guidance to thinking which will enable the learner to integrate subordinate learning sets in the performance of new tasks" (p. 16).

This is no easy task. Occasionally, however, skillful teachers are able to glean from verbal or manipulative behavior the conception or operational skill missing in a child and, then, to set about with verbal examples, exercises, illustrations, or questions to develop it. If one takes seriously the epigenetic nature of early psychological development and the results of the studies of early experience (see Hunt, 1964), this "problem of the match" takes on yet another aspect. Bruner (1965) has said: "We begin with the hypothesis that any subject can be taught effectively in some intellectually honest form to any child at any stage of development" (p. 33). Even though Bruner admits that this is a bold hypothesis, he means by "any stage" only those to be found in school-age children. Studies of early experience suggest that more can be achieved during the first two years of infancy and the preschool years than later. For these earlier periods, "the problem of the match" becomes one of providing first the infant, then the toddler, and then the preschool child with the kinds of circumstances best calculated to develop his cerebral anatomy and perceptuo-conceptual schemata and information-processing strategies at the lowest levels of the hierarchy.

To evoke development at any phase, the circumstances provided must readily engage those conceptions and strategies that the infant or child already has and then call for a modification in them. Had Socrates directed his questions to a three-year-old, they would have had about the same impact as "talking to a pig about Sunday." They would not have engaged the conceptions and skills of a child so young. As of today, our answers to this "problem of the match" rest largely on intuition, and intuition works least well for infancy and early childhood. On the other hand, at least the beginnings of knowledge are to be found in the observations of Piaget (1936, 1937, 1945).

In general outline Piaget (1947) distinguishes four periods of intellectual development. The first is sensorimotor. It begins at birth and ends, when the infant is between 18 months and two years old, with the development of imagery. This imagery is evidenced by the imitation of models no longer present, the following of objects through hidden displacements, and the solving of problems by means of mental trial and error. The second period is preoperational. It begins with the development of imagery, and it includes the basic development of such symbolic systems as gesture and language; of such "learning sets" as (1) that things have names, (2) that things come in classes, (3) that events have causes; and of various still poorly-understood intuitive strategies for the processing of information. This intuitive phase terminates, when children are about six or seven years old, with the gradual development of concrete operations. The third period, concrete operations, begins, shortly after children enter school, with the development of several logical operations. One is transitivity, evident in the ability to serialize objects according to such dimensions as perceived length, height, or gross size. A second is reversibility, evident in the ability to conserve quantity and number even when a transformation is reversed. A third is associativity, evident in the capacity to deal with part-whole relationships. A fourth is identity, also evident in conservation of quantity and number. The conservation of gross quantity is then followed by conservation of weight, and the conservation of weight is followed by conservation of volume; all come with learning the multiplicative compensation of dimensions (Inhelder and Piaget, 1955). During this third period, the child provides other evidence of his concrete operations in his capacity to cooperate in social situations, e.g., to play games with rules, and in his elaborations of causality, spatial perspectives, and time. This period ends and the fourth period — formal operations — begins with the use of the proportionality schema and with the ability to operate logically with propositions. While the child with only concrete operations must limit his concern to how observed things go together in classes, orders, and numbers, the adolescent with formal operations can consider a general law because he can deal with the hypothetically possible as well as with the perceptually evident. Whereas observation directs the thought of the child with concrete operations, thought directs the observations of the adolescent with formal operations. With the development of the formal operations, adolescents manifest in their problem-elicited thought evidence of such logical schemata as the 16 operations of binary propositional logic and the INRC group first made clear by Boole (1854). With the development of formal operations the adolescent achieves access to the hypothetical-deductive methods of science. Moreover, because he can view the world as it might become, he is also inclined to become intrigued with possibilities of social reform. Note, however, that when planners (Bruner, 1965, for example) consider only the last two of Piaget's four periods, they disregard the very large portion of intellectual development occurring during the first two periods.

Sensorimotor Stages and the "Problem of the Match"

Although the six stages identified by Piaget (1936) within the sensorimotor period may be artifacts of encountering a variety of things at approximately the same rate, they suggest at least tentative solutions to the "problem of the match" during this period. The first stage begins with birth and the ready-made sensorimotor organizations of sucking, grasping, vocalizing, looking, listening, and wiggling the body. Apparently most important during this stage are adequate food and the opportunity to exercise these ready-made sensorimotor organizations that Piaget calls schemata. This first stage ends and the second one begins, at approximately four weeks, with the appearance of the first primary circular reactions. These primary circular reactions are coordinations of the ready-made sensorimotor organizations; the coordinations include mouthing saliva, sucking the thumb, hand-watching, babbling, or looking at the source of sound. Originally, each sensorimotor organization has its own instigator: a change in the intensity of light instigates looking, for instance, and a change in the characteristics of sound will stop activity, implying that it has instigated listening. When something heard becomes something to look at, however, a coordination has taken place: a change in sound will instigate looking. Hand-watching constitutes a similar coordination between arm movements and looking; babbling constitutes one between listening and vocalizing. During this second stage, from roughly a month to four or five months of age, apparently most important is varied input through the eyes and ears. It is also probably important to have auditory changes followed by visual events.

The second stage ends and the third stage appears with what Piaget terms secondary circular reactions, when various motor activities are coordinated with perception to form intentional acts. It is at this third stage that spontaneous or "operant" activities and their external, perceptual consequences become evident. It is as if the infant had acquired a "learning set" which one might verbalize as: "If I do something I can make something interesting happen." What interests the infant are the repeatedly-encountered now-familiar perceptual events and scenes. Moreover, he begins to imitate actions already well-established in his repertoire. (Experiences based upon the schedules of reinforcement in Skinner's operant procedures may well be highly important during this third stage. Piaget (1936) found it beginning when his children were four or five months of age, but some of my own observations suggest that it may be developed earlier by means of a series of operant procedures.) During this third stage, the infant develops prehension and coordinates it with vision in visually-directed reaching; he begins searching visually for objects which have vanished, and he develops subjective temporal organizations.

This third stage ends and the fourth begins, at eight or nine months of age, with the appearance of coordinations of the secondary circular reactions into means-end relationships. Thus, grasping something seen may become an end, while striking, pushing, and perhaps crawling may become means to achieve the end. During this fourth phase an infant develops active manual search for vanished objects, but he takes no account of the sequence of visible displacements: when an object disappears in a new place, for instance, the infant will look where the object was found before. An infant in this phase also begins to anticipate events that are quite independent of his own actions.

This fourth stage ends and the fifth begins, early in the second year, with the appearance of tertiary circular reactions: the infant's attention shifts from his own actions to what happens to the objects he manipulates. In his own children, Piaget (1936) observed the emergence of this fifth stage in the throwing schema. The infant appears to discover, perhaps accidentally, that he can let objects go, then that he can force them through varying projectories by varying his own effort as he lets them go. This gradual "discovery of new means through active experimentation" is manifest in a variety of different situations (Piaget, 1936; Hunt, 1961, p. 149). It is the beginning of behavior modification through groping to achieve various kinds of goals. Most of these goals, however, appear to belong within the infant's various sensorimotor organizations; the few groping behaviors designed to escape pain or to get food or water take very little of an infant's time. During this fifth stage, the infant will imitate gestures and verbal patterns not already in his repertoire. Moreover, object permanence becomes highly developed, as indicated by the fact that the infant will follow an object through sequences of visual displacement and will look in the new place of disappearance without turning back to the place where he found it before. Apparently most important for development in this stage is a variety: of objects to manipulate, of models to imitate, and of situations in which the infant can, by his locomotor and manipulative efforts, get novel things to happen.

This fifth stage terminates and the sixth begins, between 18 months and two years of age, with such image-implying behavior as following objects through invisible sequences of displacement, imitating models no longer present, and inventing new means through mental combination. Imitation increases, and with it the importance of appropriate models. With the development of imagery, the infant can begin to acquire language, and both appropriate verbal syntactical models and reinforcement become highly important.

Since adult intuition is probably the least productive solution to the "problem of the match" during the sensorimotor period, solutions must come from genuine knowledge of infant development and learning. While Piaget's (1936) stages are suggestive, they must be tested by such experimentation as B. L. White and his collaborators have begun (see White, Castle & Held, 1964). Piaget's stages may well be artifacts of infants' encountering the same varieties of objects and scenes at about the same rates; perhaps infants who encounter a wide variety of visual scenes but a limited variety of auditory patterns would develop visuo-motor coordinations even earlier than Piaget's children, but develop auditory-vocal coordinations considerably later than they.

Even so, Piaget's observations provide a nice illustration of the hierarchical principle of organization in intellectual development. The various schemata ready-made at birth become coordinated; then these coordinations become coordinated again. This integrative process, complemented by differentiations, appears to repeat itself indefinitely. Motor acts and perceptions lead to representative central processes, or imagery, and images supply the referential basis for the symbolic processes and, later, for the intuitive modes of information processing.

The Preoperational Period and the "Problem of the Match"

Adult intuition still does not produce many solutions to the "problem of the match" during the preoperational period, especially during its earlier portions. Although Piaget (1945) has published his description of the origin of symbolic processes, based on observation of his own children, his observations are far less complete for this period than they are for the sensorimotor period or for the later periods on which he has more recently concentrated. Language is central to these symbolic processes, but considerable evidence indicates that the rudiments of thought in imagery and infantile intuitions underlie language. The veil over development during this period resides partly in the discrepancy between infantile and adult images and intuitions and partly in the fact that the infant may use vocal patterns approximating those of adults but with very different imaginal and intuitive referents for the vocal signs. Although students of both linguistics and psychology (see McCarthy, 1954), have written much about the acquisition of language, they have agreed upon no synthesis of beliefs which might serve as a source of suggestive solutions to the "problem of the match" during this period.

Skinner (1957) has presented verbal behavior as "a repertoire of responses existing in various states of strength under the control of variables in the environment and in the history of the speaker" (p. 311). From the standpoint of his S-R conceptualization, speech is behavior which has its first effect as a communication with other men, who then act upon the environment to achieve the goals of the speaker. Skinner's attempt to explain thought in terms of verbal behavior descriptive of the speaker's own behavior, i.e., the autotelic, is in some ways attractive, but it leaves out of account a variety of stubborn facts. For instance, successive phases of psychological functioning appear to be associated with an increasing role for central processes and with their increasing dominance over perception and action. This hypothesis has been suggested not only by the observations of Piaget and the studies of the changes in perceptual illusions with age (Piaget & Lambercier, 1943a, 1943b, 1946), but also by the fact that the electromyographically indicated tension in the muscles involved in thought and problem-solving disappears as practice with problems continues. This principle holds both for the muscles of speech (Lashley, 1958) and for the muscles of the fingers of deaf mutes (Max, 1934, 1935, 1957). Moreover, there is an evidence of loci within the brain for certain rough categories of thought: evidence shows that damage to the fiber tracts underlying the parietal and temporal lobes produces deficits in recognitive functions but that damage to the fiber tracts underlying the frontal lobes produces a deficit in executive functions or planning (see Pribram, 1960, for a review of this evidence). Moreover, from a developmental standpoint, images appear regularly before language appears. This holds for both phylogenetic and ontogenetic development. For phylogenetic development, Hebb and Thompson (1954) have called attention to the fact that chimpanzees behave in a fashion implying both imagery and thoughtful plans; but chimpanzees do not talk. For ontogenetic development, Piaget finds evidence that a child imitates objects no longer present, solves problems by means of mental combination, and follows objects through series of hidden displacements well before he has developed more than a few pseudo-words. Such evidence indicates that thought and language are far from coextensive functions. In fact, Piaget's (1945) observations appear to indicate that an infant's first spoken pseudo-words symbolize his own highly ideosyncratic imaginal congeries of objects, persons, and scenes. The significance of this was brought forcefully home to me in the apparent referents for my daughter's garbled "mail man" — mai-ma — an episode which I have discussed elsewhere (Hunt, 1961, p. 186).

In spite of the lack of information and the disagreement about the development of thought and language, certain phases can be identified. First, it is only after a child has acquired a number of pseudo-words that he learns that "things have names," a kind of learning set marked by the appearance of the infant's gestures of "What's that?" Later the question is verbalized. Second, in many instances the names of objects are defined in terms of the use of the object, but children's questions imply other meanings as well. For instance, the question "Why?" (see Nathan Isaacs, 1930) implies a kind of dim realization that events have causes. Similarly, the question "Is it a this or a that?" implies an appreciation that things come in classes. Such information is crude indeed. It lacks any semblance of the hierarchical organization so evident both in the sensorimotor period and in the period of concrete operations. Information about the steps in the hierarchical organization of thought in this preconceptual period is required before we even make merely suggestive solutions for the "problem of the match." The kind of observational investigation that Piaget provided for the sensorimotor period is very much needed on the development of thought and language during this period.

Although our picture of the natural epigenesis of thought and of the acquisition of language during this intuitive-preoperational period appears to be even less clear than our picture of development during the sensorimotor period, this may not be fatal for guiding learning during the later phases of the period. Much can be done to overcome the deficit resulting from opportunities to observe and manipulate only a very few objects, from inadequate linguistic models, and from demands for obedience that serve to limit the toddler's exploratory activity. Half a century ago Montessori was reported by such dependable observers as Fisher (1912), Stevens (1913), and Warren (1912) to have had considerable success in overcoming some of the effects of such cultural deprivation in the children of the slums of the San Lorenzo district of Rome. At her *Casa de Bambini*, Montessori put great stress on the training of what she called sensory processes, or what we might today call recognitive information processes. She also broke the lock-step in the education of preschool children by supplying them with a wide variety of materials which they could manipulate. These varieties were arranged in progressive levels of complexity leading to reading and writing. Moreover, by having together children from three to six or seven years old, she provided the younger children with a progressive variety of models for imitation, and the older ones with an opportunity to learn by helping and teaching the younger ones.

Within the last few years, recognition of the possibility of using preschool enrichment as an antidote for cultural deprivation has given a new emphasis to the importance of learning and intellectual development within nursery schools and kindergartens. Martin Deutsch in New York, Susan Gray at Peabody College, O. K. Moore at Pittsburgh, and Glen Nimnicht at Greeley, Colorado, have all attacked this problem, using various methods with considerable success. In general, all of these innovators have given more emphasis to the roles of language and of action than did Montessori.

Especially interesting is the work of O. K. Moore with the "talking typewriter." It is interesting because an instrument, albeit a very expensive one, appears to be able to do the teaching (see Moore, 1963). This fact gives promise of overcoming the shortage of skilled teachers and perhaps of ultimately reducing the cost of teaching services. On the other hand, it is not yet clear from the evidence available whether the existing programs with the "talking typewriter" will inculcate all the skills of thought and language that children need.

Impressive to me in terms of results obtained, perhaps because I know them first hand, is the approach of Bereiter and Engleman (1966). From the fact that the deaf show much more intellectual deficit than the blind, these investigators gleaned that linguistic interactions are probably more important for cognitive development during this preoperational period than are the sensorimotor encounters with objects and materials stressed by Montessori and emphasized in my own discussions (Hunt, 1961, 1964). In consequence they have based their own program of teaching culturally-deprived preschool children on an *a priori* analysis of the skills needed for success both in traditional schools and in those schools teaching by the "discovery" method. Bereiter and Engleman presumed, first, that enriching merely by increasing the variety of objects and scenes encountered and the variety of models for imitation would not overcome the culturally-deprived child's backwardness in the skills necessary for later academic success. Second, they presumed that explicit training in the formal, structural aspects of language would have great value. They have modeled their program on the new techniques for teaching a foreign language, on the assumption that the established language patterns of the culturally-deprived child lack the formal properties necessary for the organization of thought. They have put their major concern on the acquisition of grammatical statement patterns and on a capacity to use the logical organization of these patterns to answer questions. They have seen precise pronunciation as a critical requirement for mastery of grammatical structure. They have allowed vocabulary development to occur as an incidental outcome of work on grammatical structure, and they have taught concepts chosen because of their value in organizing experience and in making logical distinctions, concepts concerned especially with the names of classes and of various relationships. Their basic technique has consisted of getting a child to repeat verbal statements containing a concept, while at the same time supplying him with at least a minimal sensorimotor example of the concept. Thus, when the child is asked to say, quite clearly so that the others can understand him, "This ball is hard," he is given a golf ball that he cannot dent when he presses it. Contrariwise, when he is asked to repeat, "This ball is soft," he is given a tennis ball with low pressure so that squeezing will dent it. Moreover, the children are required to say why the golf ball is hard ("because I cannot dent it") and why the tennis ball is soft. Beyond repeating sentences, a child is asked questions which he can answer deductively directly from the structure of the statements he has been repeating. Thus, questioning brings about discriminations between relational prepositions that are often troublesome. After the child has been shown a crayon in a box and has been asked to say: "The crayon is *in* the box," he can be asked the question "Where is the crayon?" The teachers require a full statement and answer, i.e., not merely "in the box" but "The crayon is *in* the box." In an alternate case, a child can be shown a crayon *on* a box and be asked to say, "The crayon is *on* the box." He can then be asked, "Is the crayon *in* the box?" and must answer, "The crayon is not *in* the box; the crayon is *on* the box." Similar procedures are used for above-under, beside-between, in front of-in back of, etc. Bereiter and Engleman have also taught arithmetic as a language, and Engleman has employed with arithmetic procedures like those above.

Bereiter and Engleman run their school quite formally, in what they call "a highly task-oriented, no-nonsense manner," for two hours a day, five days a week. Individual sessions with a given teacher are limited to 20 minutes and are separated by periods of song or play or juice, but even these refreshment periods are organized to foster linguistic and conceptual development.

Although the design of their demonstration employed no control group, the results of their program are indicated in several ways. One is changes in scores on three subtests of the Illinois Test of Psycholinguistic

Abilities (Kirk & McCarthy, 1961). Only three months of such training resulted in improvements of 13 months on the auditory-vocal automatic subtest and on the auditory-vocal association subtest and in an improvement of 15 months on vocal encoding. The *auditory-vocal automatic* subtest is essentially one of ability to use grammatical inflections for the formation of plurals and comparatives. Culturally-deprived children typically do especially poorly on this subtest. The *auditory-vocal association* subtest consists of simple verbal analogies, and scores on it have been found to show substantial correlation with scores on the Stanford-Binet test of intelligence. In the case of the subtest called *vocal encoding*, an object is presented and the subject asked to "tell me all about it." Scores are based on the number of different appropriate things that the subject says about each object. The fact that the children showed a 15-month improvement on this test suggests that the training generalized beyond the simple language patterns in which the children had been coached. The second three months of such schooling produced approximately another year of gain on these subtests of the Illinois Test of Psycholinguistic Abilities: median scores shifted from retardation of about a year to a median psycholinguistic age corresponding to their chronological age. A second indication of the results of the program — one even more impressive to me than the score changes — is the observation by teachers and drivers that the children showed markedly improved communication in their play and while riding to and from school. These observations suggest that the training succeeded in increasing spontaneous communication among the children and, perhaps, reduced what Piaget (1923, 1924) called the egocentricity of communication in preschool children. Also impressive is the fact that the most common comment of the mothers of these culturally-deprived children has been an equivalent of "I can understand the child better now." One mother said to me, "Ah neva could unnerstan tha chile, but ah can now." It would have been exceedingly helpful in interpreting these findings to have had a control or comparison group with other kinds of experience, but one knows from general observation that such changes do not occur spontaneously.

While the structures of thought are not coextensive with the structures of language, especially in the very early stages of language acquisition, the findings of Bereiter and Engleman suggest that the structure of thought and the structure of language become more nearly coextensive with time. The success of their teaching is also consonant with their supposition that structure of language is crucial for the development of logical thought. This belief I did not share, but the apparent success of their teaching moves me. It is not entirely clear what conceptual equipment a child must have in order to profit from the teaching method of Bereiter and Engleman. Neither is it clear how much behavior that requires thought is altered by their teaching. It would be very interesting to determine whether children who have encountered their teaching will conserve quantity and number and will show the capacity for seriation earlier than culturally-deprived children who have not. Such evidence will determine whether such teaching does hasten the development of operational thought. The ultimate assessment of the value of such preschool programs must come, of course, from the degree to which they improve the later performance of culturally-deprived children in regular schools.

Concrete and Formal Operations and the "Problem of the Match"

Once children have mastered the structure of spoken language and have acquired the concrete operations (transitivity, reversibility, associativity, and identity) of thought, their communications quite often supply adults with the evidence of what is missing in their attempts to solve given problems. With the concrete operations, observed by Piaget to typically come at roughly six or seven years of age, Bruner's (1965) hypothesis that "any subject can be taught effectively in some intellectually honest form to any child at any stage of development" becomes essentially true. What is now called the "discovery method," epitomized in Socrates' discourse with the slave-boy, is probably the most advantageous approach to the teaching of children who possess the concrete operations but have not yet acquired the formal operations of thought. The considerable success of teaching by the discovery method in mathematics [for the work of Beberman and his collaborators at Illinois, see Hale (1961), Golden (1963), and Szabo (1964); and for the work of Rosenbloom, see 1958a, 1958b,] and in physical science (see Karplus, 1964) supports the hypothetical value of this method at this stage of development. Moreover, the pioneering work of Ojemann (1948, see also Ojemann et al., 1955) and the studies of Muuss (1960a, 1960b, 1960c) suggest that the concrete operations can also be usefully applied to understanding human behavior in what Ojemann and Muuss have called "causal learning." A similar approach has been employed by Ronald Lippitt (personal communication) to teach children to think objectively about values. Finally, Suchman (1960a, 1960b) has employed a form of the discovery method with children in the later phase of the period of operational thought to teach skill in inquiry. Suchman's results suggest that learning to ask and to plan readily-answerable questions may hasten the development of the formal operations of thought wherein thought directs observation.

Once young adolescents have acquired at least the beginning of formal operations, on the other hand, the discovery method becomes comparatively inefficient. The acquisition of formal operations makes it quite feasible to teach general principles with language, as Ausubel (1960, 1963) has demonstrated. Even observational facts are more readily learned after the learner has obtained via linguistic communication the principle to which the facts are relevant. These results of Ausubel (1963) and others suggest that programmed instruction aimed at the shaping of verbal behavior (e.g., Holland & Skinner, 1961) cannot hope to achieve the wonderful consequences for education that Skinner and his followers have envisaged. In this connection, it is interesting to listen to the comments of college students who have served as subjects in the tests of such programmed instruction. The most common comment I have encountered concerns its boring laboriousness. This is commonly coupled with reports that it is much more interesting and much less time consuming to read an ordinary textbook to get the same information. In fact, at least one of these subjects has confessed that the boredom of the program motivated him and his friends to find a traditional text covering the material. These observations take us to the motivational side of the "problem of the match."

Motivational Aspect of the "Problem of the Match"

Motivation from painful stimulation and homeostatic need appears to undergo no major epigenetic transformations, even though learning plays a considerable part in their development (Bindra, 1959). Although Freud (1905) described an epigenetic development of the sex drive during infancy, it now appears highly unlikely that sex has anywhere near the importance for intellectual development that Freud attributed to it (see Hunt, 1963a). Evidence has been growing, especially since World War II, to indicate that there is another major system of motivation inherent within the organism's information processing and action (see Hunt, 1963a). This system of motivation, which I have termed "intrinsic motivation," appears to be the one of central importance in intellectual development. The "problem of the match" enters intrinsic motivation when, in the course of its developmental epigenesis, the infant becomes interested in what for him is somewhat incongruous or novel, when the infant becomes interested in informational input which has an appropriate degree of incongruity with that he has already absorbed (see Hunt, 1965b). At this point, circumstances with too little incongruity become boring (Bexton, Heron, & Scott, 1954); those with too much incongruity become frightening (Hebb, 1946). The "problem of the match" is one of supplying the infant or the individual, at every stage of his development, with circumstances with an appropriate degree of incongruity to be interesting and/or somewhat surprising and, so, to provide a basis for intellectual growth.

Although Piaget was avowedly unconcerned with motivation, his observations of his own children imply both the existence of intrinsic motivation and the general nature of its epigenesis during the first two years of infancy (Hunt, 1963b), and a few of his generalized statements have motivational import. He has stated, for instance, that "the more a child has seen (and heard) the more he wants to see (and hear)," a statement suggesting that the development of interest is a function of experience. Elsewhere, Piaget (1945) has also stated that "interest is merely the affective aspect of assimilation." In other words, that which is in the process of becoming assimilated is interesting. Charlesworth (1964) has extended this principle with the interesting suggestion that "surprise be considered the affective aspect of accommodation." He notes that when a child is observed in a problematic situation, the child first applies his ready-made action systems and information to the solution of the new problem. When these fail and the outcome differs from his expectation (when the child's attempt at what Piaget calls assimilation fails), the child is commonly surprised. If the surprise-producing discrepancy is not so great as to invoke fear, the chances are that the child will continue to be engrossed with the situation and will, in consequence, modify his existing systems of action and conception. It is in just such situations that one finds modification of behavior and belief in a temporal relationship opposite to that described for reward learning or operant conditioning. The "problem of the match" is one of providing the young with circumstances so related to what he has already encountered and acquired that he will be interested and perhaps surprised.

EPIGENETIC STAGES IN THE DEVELOPMENT OF INTRINSIC MOTIVATION

The developmental epigenesis of that motivation inherent within the organism's informational interaction with circumstances begins at birth. In the case of such motivation, the instigating condition is incongruity of input with an existing standard. At first infant mammalian organisms respond to changes in the various characteristics of on-going inputs. What is on-going provides the standard, and change provides the instigating incongruity. Infant organisms are, of course, responsive also to painful stimulation and homeostatic needs, but the responsiveness to changes of input through these distance receptors occupies the infant when he is not in pain, not hungry, and not asleep. Although there is Freud (1905) to the contrary, sex probably plays a minimal motivational role during infancy.

In the earliest phases, this response to change of on-going input has two aspects, as demonstrated by the investigations of the "orienting response" by the Russian investigators (see Berlyne, 1960; Razran, 1961; Simon, 1957). One aspect of this response is *arousal.* This aspect is indicated by such expressive indicators of emotion as the galvanic skin response (GSR), alterations in heart rate, vascular changes (plethysmograph), and changes in the electroencephalogram (EEG). The other aspect of this response is *attentional.* This aspect is marked by cessation of activity in progress, orienting to listen or to look, etc. One gleans from Piaget's (1936) observations that this first responsive phase of the development of intrinsic motivation endures through much of the first four, possibly through the first five, months. During this phase, the infant learns to coordinate his relatively separate ready-made systems. Thus, something heard becomes something to vocalize or to look at; something to look at becomes something to reach for and grasp; and something to grasp becomes something to suck.

The second phase of this epigenesis comes gradually with the repeated encounters with given patterns of change in input during the first phase. Repeated encounters with patterns lead presumably to the gradual establishment of central templates which permit recognition of the patterns. Recognition appears at first to make any pattern attractive. Evidence for the attractiveness which appears to accrue to perceptually encountered patterns comes from the ethological phenomenon called *imprinting* wherein objects seen and heard during the early hours or days following hatching or birth come to instigate following responses (Hunt & Uzgiris, 1966; Thorpe, 1956). In one preliminary experiment, this hypothesis that attractiveness comes with recognitive familiarity has been tentatively confirmed by a tendency of infants to look longer at newly familiar patterns than at strange ones (Uzgiris & Hunt, 1965). When a child of about two months is given an opportunity to look at a mobile which has become familiar because it has hung over his crib for a month, and to look at another unfamiliar mobile which is presented simultaneously, the child looks more at the familiar one than at the unfamiliar one.

Efforts to prolong, or regain, perceptual contact with objects, persons, and scenes that have become attractive through recognitive familiarity imply *intention* as well as attention. In these efforts, the infant is no longer merely responsive; he is, rather, independently initiating an effort to prolong or regain perceptual contact, and this initiation contains within it an implicit goal. Moreover, such a goal has nothing to do with painful stimulation, homeostatic need, or sex. It appears to be inherent within the infant's perceptual interaction with his circumstances. Thus, intrinsically motivated actions appear to have their developmental origin in recognitive familiarity.

Spontaneous efforts to hold on to patterns made attractive by newly acquired recognitive familiarity correspond in many ways to the operant responses of the Skinner system. Moreover, this effort to prolong or regain perceptual contact with scenes becoming recognitively familiar may well be what motivates the hand-watching and foot-watching so often observed in infants of four or five months of age. Such efforts may also motivate the babbling through which infants even younger develop ear-vocal coordination. Such motivation may also account for the excited interest that infants show when adults present familiar patterns of gesture and vocalization, and for the infant's responsive imitation of these patterns. With the development of that primordial form of intention wherein the infant acts to prolong or regain perceptual contact, one finds the beginnings of a separation of action from information processing, even though these two separate aspects of informational interaction with circumstances collaborate continually. In the case of information processing, the standard is some representational process within the brain, but in action the standard becomes the goal. Action-like goals develop also in perception. It was Woodworth (1947) who first described the goal of perception as recognitive clarity. Such a goal can hardly exist in the neonate; it must develop out of experience. Presumably, repeated encounters with new objects, persons, and scenes lead repeatedly to recognitive familiarity. Repeated acquisition of recognitive familiarity leads perhaps to a kind of learning set that one might verbalize as "things are recognizable." With the development of such a generalized set comes, perhaps, the task-like aspect of perception. Once the infant comes to anticipate that things should be recognizable, his tendency is to persist in looking at them in order to make them recognizable.

Other kinds of goals develop also during the latter portion of the second phase of intrinsic motivation. Any sensorimotor organization, or schema, can become a goal or serve as a means. One of the most common of the earliest goals is trying to grasp something seen, usually some highly familiar object. Later any sensorimotor organization, or schema, can become a goal or serve as a means. Again such goals of infant action have nothing to do with painful stimulation, homeostatic need, or sex. They appear to grow out of recognitive familiarity and then to take on goal significance of their own.

The third stage of intrinsic motivation emerges with interest in what is new or novel or incongruous with that clearly recognized. This interest in the novel may well have two motivational sources. One has been described by Hebb (1949). Scenes encountered repeatedly gradually lose interest and become boring. Hebb attributed this boredom to the fact that central processes anticipate fully the various turns of events before they arise. The result is an unpleasant synchrony of inputs with central processes. Although this is but an interpretation, it suggests one basis for the fact that children do shift from an interest in the familiar to an interest in what is relatively unfamiliar in familiar scenes. The second motivational source of this shift may arise from the set to recognize all things. These two factors would both tend to shift an infant's concerns from the familiar to the novel. This new-found concern with the novel, moreover, would also tend to move the infant's attention from his own ready-made motor patterns to the fate of the objects participating in motor patterns.

At any rate, with interest in novelty come deliberate variations in motor acts to see what happens as a consequence. Piaget (1936) has observed this specifically in connection with the throwing schema, but this same interest is manifest in the infant's modifications of his motor patterns to achieve ends, modifications which Piaget terms groping but which have also been characterized as trial-and-error. The interest in novelty is manifest also in the infant's imitation of unfamiliar vocal patterns and unfamiliar gestures.

This third phase in the epigenesis of intrinsic motivation is the final one. With it comes the "problem of the match," because too little incongruity appears to produce boredom, too much to produce fear. The fact that an optimum of unfamiliarity, or incongruity, is interesting provides an important motivation for joyful learning. Although frustration can motivate the behavioral changes that we call learning, the doctrine that all learning must be motivated by frustration (see Freud, 1933, p. 166; Melton, 1941) is simply untrue. Intrinsic motivation to learn is manifest in the exploratory behavior of animals (Montgomery, 1952, 1953a, b). It is illustrated by the fact that the monkeys in Butler's (1953) experiments learned various skills merely to get a peek through a window in their opaque cages at the scenes outside. It shows in a fascinating experiment by Dember, Earl, and Paradise (1957). These investigators presented rats with a choice between two levels of complexity in the loops of a figure-8 maze. In one case, the walls of one loop were painted with a solid color, while those of the other were painted in black and white horizontal stripes; in the other case, the walls of one loop were painted with black and white horizontal stripes, while the walls of the other were painted in black and white vertical stripes. (Horizontal stripes are more complex than solid colors, and vertical stripes are more complex than horizontal stripes because they afford more changes of on-going input.) From theorizing not unlike this about intrinsic motivation, Dember et al., claimed no way to predict which loop of the maze the rats might prefer on their first encounter with the maze, but they did predict that whenever animals registered a change of preference on their second encounter (by changing the loop in which they spent most of their time), they would change toward the more complex loop. This prediction was confirmed in 12 or 13 instances. This tendency to choose the relatively more complex illustrates that the complexity of the standard grows with experience, which, in turn, implies that spontaneous interest in learning upon which Montessori and others have based their educational programs.

Montessori (1909) started her work with the mentally retarded, was next concerned with the culturally deprived, and then with the culturally privileged. Her method was based on confronting young children with a variety of materials and a variety of models for imitation, both arranged to provide series of increasing complexity. Her assemblage of materials, selected because she observed that children were interested in them, increased as she continued her work. Her models derived from her practice of having children from three to seven years of age together in her schools. In allowing each child to choose the material with which he wished to "work" at any given time, she broke the lock-step in infant education and allowed each child to follow his interests. The result was a marked increase in the span of attention. Dorothy Canfield Fisher (1912) reported that, in place of the 10- to 15-minute spans considered maximum for three-year-olds, in Montessori's school such youngsters persisted for more than an hour at various activities, e.g., buttoning, unbuttoning, and rebuttoning on a toy-board supplied.

The vocal-motor side of language appears to be motivated intrinsically. Once interest in novelty appears, imitative vocalizing of unfamiliar vocal patterns appears. This fact helps to explain acquisition of the vocal-motor patterns. It has long been hard to believe the notion that all infants vocalize spontaneously all the phones of all languages, and that those belonging to the parents' language are learned through social reinforcement. The social side of language acquisition appears to be more than a mere reinforcing by approval or notice of vocal patterns. If the interest in novelty does provide a motivational basis for vocalizing imitatively phones that have never previously been part of an infant's vocal repertoire, then we have a more believable explanation for the fact that most of the first pseudo-words that an infant utters are approximations of adult vocalizations heard repeatedly in connection with exciting events. Imitation of novel phones verbalized by adults in association with such exciting events may provide the infant with vocal-motor patterns which can serve him as signs for the images of objects, persons, and scenes encountered in these events. In this fashion, presumably, comes a coordination of information processing and action in the early acquisition of language.

Later, reinforcement, based partially on social approval and disapproval and partially on growing cognitive differentiation, would be expected to lead gradually to vocal patterns symbolizing images which are sufficiently like those of the infant's caretakers to permit the beginnings of communication. A number of these combinations of vocal patterns and images presumably lead to the generalization or learning set that "things have names," which is marked in the behavior of the infant by actions or vocalizations meaning "What is that?" At this point, the rate at which new words are acquired takes a sharp increase (see McCarthy, 1954). It may well be that once a child has achieved this learning set that "things have names" and a readiness to accept verbal commands, he can profit from a program like that of Bereiter and Engleman (1966). On the other hand, other conceptions and attitudes may also be required. This is a matter for empirical investigation. Attempts to enrich preschool experience as an antidote for cultural deprivation typically take the child at four, and almost never earlier than three. By such ages, even most culturally-deprived children have acquired the prerequisites to profit from such a program. Typically, however, they have not had proper models of pronunciation and of syntax to imitate or sufficient verbal interaction with adults to require them to utilize language for anything beyond communicating their most primitive needs.

While the data for a theoretical solution to the "problem of the match" during this preoperational period are far from adequate, the fact that interest and surprise betoken a proper match — or perhaps one should say a proper mis-match — for evoking modifications of behavior and belief, provides a kind of practical solution for the guidance of the learning of the young. The trick is to provide encounters with circumstances of various sorts that interest the child and surprise him occasionally. Moreover, inasmuch as interest derives from the novel and unfamiliar aspects of familiar materials and events and from their increasing complexity, a way is provided to direct the child's interest toward acquiring the conceptions and skills required by our highly technological culture. Making the novel and more complex lead toward proper pronunciation, toward proper syntax of language, and toward terms for relational concepts, and using language to utilize those skills inherent in the structure of language should lead an infant with joyous interest to acquire the verbal skills required. Familiarity with books and with models of adults who read should, and often does, lead children to efforts to imitate the reading skill and, so, to learn to read almost entirely on their own initiative with a minimum of formal coaching.

O. K. Moore's (1963) approach to the teaching of reading illustrates the operation of intrinsic motivation, which Moore calls "autotelic," in another fashion. Here, the child is led to strike typewriter keys by his interest in the feedback: the letters seen typed on the page and the names of the letters heard immediately after each key is struck. The child's action is limited to striking the typewriter keys, and he is taught by way of the receptor inputs deriving from his actions on the keys. Each child is introduced to the "talking typewriter" by another child already familiar with it, who demonstrates the machine and explains that "we take turns." Thereafter the teacher of the nursery school instigates each successive encounter of the children with the "talking typewriter" by asking, "Do you want your turn?" In such circumstances, learning to read can be fun if the teaching machine is programmed to permit the child to get the feedback that interests him and properly increases the complexity of the task for him. To this end, Moore's "talking electric typewriter" is equipped with a mechanism that counts the number of strokes made per minute. When the rate of a given child's strokes drops off, it is a signal that the program needs to be modified to maintain his interest. While this is no truly experimental demonstration, it is a dramatic illustration of how such intrinsic motivation can be utilized to guide the learning of such a specific skill as reading.

Skinner and his followers also utilize the overt behavioral evidences of interest to determine what is reinforcing. In his original description of programmed learning, Skinner (1954) mentioned "the natural reinforcement inherent in subject matter." Although Skinner's aversion to theory left him quite unconcerned with any theoretical solution to the "problem of the match," a practical solution is required in order to utilize such natural reinforcement. There is no better criterion of what reinforces or of what promotes learning than observing what it is that interests a child. Once this is known, the materials can be arranged and modified to lead the child toward those concerns and skills demanded by the culture. I would still argue, however, that the central processes mediating the "three r's" are changed less by reinforcement of acts than by what children see and hear in response to their acts, and by the interest and surprise that these sights and sounds evoke. Curiously, from this standpoint, the role of reinforcement becomes mainly a matter of motivation. On the other hand, the persistence of striving and of given responses — on the side of action — and the persistence or rigidity of beliefs — on the side of information processing — are apparently produced by the schedules of reinforcement a child has encountered in his own history.

S-S RELATIONS *VS* S-R RELATIONS

Perhaps it is worth returning to the topic of S-S relations *vs.* S-R relations. While modifications of motor action through groping or from shaping with reward definitely occur, they are far from the only bases for learning and may be relatively unimportant for cognitive development. Yet, a belief that only modifications on the efferent or motor side create the central processes mediating problem-solving ability is one of the most rigid of our dogmas. This belief has one root in the evolutionary thought of the nineteenth century, in G. Stanley Hall's (1908) aphorism that "the mind of man is hand-made." It has another root in C. Lloyd Morgan's (1894) efforts to eradicate the mental faculties whose evolution Romanes (1883a, 1883b) tried to trace by observational anecdotes on the behavior of animals at various levels in the phylogenetic scale. Since these faculties were unrelated to the history of either receptor inputs or motor outputs, Morgan did well to get them out of the lexicon of psychology. But the belief that only motor modifications affect problem-solving got momentum from Thorndike's (1913) emphasis on connectionism and from Watson's behavioristic revolt from mentalism. It has been perpetuated in the theorizing of Hull (1943) and of Miller and Dollard (1941), in Osgood's (1952) theory that the mediating processes derive from the lighter, or muscularly less-effortful portions of an organism's responses to situations, and in

Skinner's (1953a, b) emphasis on the observable response and its consequences. Accumulating evidence, however, implies that experiences which involve chiefly the effects of inputs do have substantial consequences on later behavior. As already noted above, the recent evidence comes from several sources. One consists in the effects of early sensory deprivation on both later behavior and on neuroanatomical maturation. Another consists in the effects of sensory enrichment on both later maze-learning and on neuroanatomical brain chemistry. A third, but less well-established body of evidence, consists in the effects of recognitive familiarity on cathexis — as manifested both in imprinting and in certain choices of familiar over unfamiliar objects — and on imitation. In Mowrer's (1950) training birds to talk, the sound patterns guided imitative activity. Mowrer kept his birds' cages covered except when he fed them, at which time he also made the sound patterns for them to imitate. As Mowrer interpreted his findings, the feeding lent value to the sound patterns he uttered. But it is very likely that the feeding was unnecessary: Piaget's (1936) observations indicate that children will imitate familiar patterns, and it can probably be demonstrated that Mowrer's birds would have learned to talk even if food had been continually left in their cages. Probably most important is removing the cage covers before presenting the sounds to be imitated. It can probably be demonstrated also that the sounds infants make in their babbling are controlled by the patterns of vocal sounds to which they are repeatedly exposed, even when these sounds are quite unassociated with any gratification of homeostatic needs.

Interesting and suggestive evidence especially relevant to guiding the learning of the young comes from two other sources. One is the program with which O. K. Moore (1963) teaches three-year-olds to read. The other is Shinichi Suzuki's program for teaching preschool children to play the violin (see Time Magazine, 24 August 1959; Kendall, 1960).

Moore noted that once children have two or three months of exposure through the "talking typewriter" to the sight of the various letters and to the sound of the letters' names, they spontaneously learn to make the letters with chalk or pencil. First, given chalk and a blackboard, they soon find that some of their scribblings resemble letters. Then, when their loop is identified as the letter "O," their straight vertical line identified as the letter "L," and two or three more such identifications made, they typically announce with delight, "I can make the letters." This statement reflects a kind of learning set. Moore (personal communication) thought he noted that the motor control manifest in the writings of these very young children looked unusually good. When he had the written letters made by such children judged for motor control by experts who felt they could estimate the age of children by means of the motor control evident in their writing, the children were judged to have control typical of children seven, eight, or nine years of age. If controlled experiments should verify such suggestive evidence, it would mean that images derived from repeated encounters with visual patterns can serve as a basis for motor control even in preschool children.

In Japan Suzuki developed a program for teaching violin to young children which consists of several well-defined steps modeled on his conception of children's spontaneous language-learning. During their second year and even during the latter part of their first year, he has infants repeatedly hear recordings of a variety of simple themes played by an expert violinist. As the infant develops into toddlerhood, Suzuki teaches the mother to play some of these themes. The recorded themes presumably yield auditory images which can later serve as a standard against which the child's own efforts are automatically compared. The mother's playing provides a model. Suzuki expected children to try to imitate their mothers' playing just as children try to imitate their mothers' vocalizations and performance of various household tasks. Suzuki's expectations were confirmed, and once a child asks repeatedly to play his mother's violin, he is given a small violin of his own. While he is enjoying his new "toy," he is also given some simple coaching on how to use his left hand to get tones and on how to use his right hand to bow. The consequence of this program is that thousands of preschool Japanese children learn to play the violin with what American string teachers consider a very high quality of performance. Paul Rolland, president of the String Teachers Association in America, has reported that four-year-olds and five-year-olds taught by Suzuki's methods obtain as fine a quality of sound from their little half-violins as do all but the best high-school-age violinists in America (personal communication). If controlled experiments verify Suzuki's work, this work will indicate that the auditory images based upon repeated hearings of expert violin recordings serve as standards to guide the motor side of a very young child's effort to play the instrument.

People fairly accomplished at any skill have always learned much by observing the experts. Painters learn from watching other painters. Pianists learn from watching and listening to other pianists. Professional football players study the movements of their future opponents in motion pictures of previous games as a method of preparing themselves to counter those movements in the competition to come. It has generally been believed that such learning from observation is possible only for those already skilled, that observing the movements of others is useful only to those who have already achieved considerable skill at the movements observed. The evidence from Moore and Suzuki, however, suggests that the imaginal patterns acquired through repeated perception of visual shapes or musical themes can serve as standards that will later shape the motor actions required to produce the shapes or themes. Montessori's "training of the senses" was apparently wiser than we then knew; it probably achieved the establishment of the images, or representational central processes, which can serve later to guide both perception and action. Whether or not my earlier suggestion that all modification of representational central processes may be forced by inputs discrepant with those already in the storage be true, these various considerations indicate a much greater role for the input side in learning, even in the learning of the very young, than recent theories have given it.

PSYCHOLOGICAL TESTING AND THE "PROBLEM OF THE MATCH"

While behavioral evidences of interest and surprise can provide a practical solution to both the intellectual and the motivational aspects of the "problem of the match," those who guide the learning of the young are frequently in no position to obtain or use such evidence. Great social mobility means that a teacher often faces children about whose previous experience she knows nothing. Large classes leave a teacher little time to try out materials and exercises to discover what may interest or surprise any individual child. In such situations, getting the information for even a practical solution to the "problem of the match" calls for a diagnostic use of tests in education.

Although the testing movement began with an effort to improve the education of the retarded, the splendid exploratory work of Binet and Simon (1905, 1908) got twisted in America. The twist came partially from the presumption of predetermined development that Galton (1869, 1883), G. Stanley Hall (1923), and others considered implicit in Darwinian thought, and partially from the usefulness of the tests to select effective officers in World War I. The use of tests to select people for specific functions got further encouragement in industry and has recently been most evident in educational admission policies, particularly to prestige colleges. In this selective role, tests constitute a method of ranking individuals. Tests have also been used to assess achievement in education (see Cronbach, 1960), but here they are a method of ranking of individuals according to the excellence of their achievements.

The concept of intelligence as a hierarchy of problem-solving capacities suggests for tests a diagnostic function in which the individual's rank in a group is of no import. The function would be to ascertain which abilities, which symbolic representations and information-processing strategies, are present and which are absent. Such knowledge could then be used to determine whether a given individual could profit from a given educational experience or not.

Various achievement tests have already been employed occasionally in this fashion. For instance, it has been obvious that inability to read effectively makes it impossible for a child to obtain much information about geography or history, or even to enjoy the plethora of written materials available in our culture. Conant (1961) has noted that "with the difficult task of teaching reading, it is well worth pointing out that without the development of modern testing, what is now being accomplished [in the way of remedial reading and in overcoming the factors working against all forms of intellectual effort in the slums] would be quite impossible. I am convinced that 50 years ago in all communities, even 15 years ago in many schools, the slow reader was not identified, or, if identified, was just ignored" (p. 29).

For an earlier stage of intellectual development, Kirk and McCarthy (1961) have developed a diagnostic instrument based upon Osgood's (1957, p. 357) generalized behavioral model of representational mediation, with their assumed central, neural correlates. The purpose of their instrument is to get information to direct remedial efforts at educating the mentally handicapped. The Illinois Test of Psycholinguistic Abilities (ITPA) is a series of nine subtests. Six of these concern the representational level: (1) auditory decoding, (2) visual decoding, (3) auditory-vocal association, (4) visual-motor association, (5) vocal encoding, and (6) motor encoding. Three concern the automatic-sequential syntactical process: (7) auditory-vocal automatic ability assessed by a grammar test, (8) auditory-vocal sequential ability assessed by a digit-repetition test, and (9) visual-motor sequential ability assessed by a test requiring the reproduction of visually presented sequences. Although this instrument has limitations, special deficits uncovered by it have suggested special corrective training procedures and ways to measure the procedures' effectiveness.

We need a variety of instruments to assess the presence or absence of the learning sets that presumably underlie an individual's ability to acquire a given skill from a given educational procedure. What intellectual sets and motivational sets must be present, for instance, for a preschool child to profit from the program of Bereiter and Engleman (1966), wherein formal training in the structure of language is coupled with concrete illustrative experiences to bring the imaginal referents and the terms of language into congruence with social standards? What learning sets must be present, for instance, for a child to profit from the inquiry training of Suchman (1960b)? Clearly Suchman's program requires the child's appreciation of such phenomena as the collapsing varnish can and the Cartesian diver; it requires that the child's conceptions permit him to be surprised and intrigued by these phenomena.

THE CHALLENGE: GOALS, PLANNED GUIDANCE, AND TEST DIAGNOSIS

The burgeoning technology of our culture and the increasing complexity of the problems to be solved by our society call for increases in the level of intellectual competence as great as those between the medieval serf or the illiterate frontiersman of the past and the professional machine designer, corporate executive, or scientific investigator of our day. Nothing less is required than a marked increase in capacity to process information and to solve problems involving the top-most levels of logical and mathematical systems. Inasmuch as no culture has ever come close to maximizing the biological potential of human beings, this new goal would appear to be well within the range of man's potential. Just as the grandsons of African Bushmen in Ethiopia are now piloting jet planes over the earth, our children and grandchildren must be expected to surpass us substantially in all kinds of intellectual abilities. The question is how we may soon bring about such increased capacity.

Existing standards of intellectual functioning and traditional forms of education cannot achieve the goal, but neither can they be discarded like old clothes. Revolution is inappropriate except within the domain of attitude and belief concerning the possibility of ordered, evolutional change. To push the change as rapidly as possible without producing the disorder of revolution calls for a remarriage of psychology and education to undo the unfortunate divorce of about a half-century ago. I believe both developmental psychology and the psychology of learning (as corrected by evidence from both developmental psychology and physiological psychology) will be especially helpful in providing hypotheses for testing in educational practice. But education must become truly experimental to provide the data to test the hypotheses and to provide a sound basis for the reforms needed. The day is gone when a few hours of practice can yield adequate evidence. In the case of the various preschool programs, the ultimate criterion for their evaluation must come from the success of children exposed to them as compared with the success of other children not exposed. Even the data required to test the hypothesis from which these programs derive (i.e., that fostering early development will improve later scholastic performance) must come from extended investigations of given samples of children through several years. But this is not all. In many instances, the traditional educational programs into which children are placed after encountering programs of infantile or preschool enrichment may be so stultifying as to nullify large portions of the gains obtained. It may often be necessary to change the traditional programs in order to obtain suitable evidence to confirm or disconfirm the hypothesis.

To become fruitful, any such remarriage of psychology and education must, I believe, take into account simultaneously the goals of education, the epigenetic nature of the psychological development of human infants and children, and the social realities.

The goals of education have, I believe, recently become clearer. Participation in our highly technological culture calls for high competence in the use of our symbol systems of language and mathematics and for ability to think and to appreciate evidence. The rapidity of technological change demands that all individuals have the ability to cope with change and that the leaders have the ability to foresee and direct change with human values in view. Rigidity of action-habits and beliefs has become maladaptive.

The epigenetic nature of psychological development calls for a genuine solution to what I have been calling "the problem of the match." The behavioral evidences of interest and surprise provide a practical solution to this "problem of the match" at one level, but only for those who have the skill and the time to observe these evidences and the ingenuity to develop and to try out various teaching materials and devices. For most teachers of our young, however, the social realities of increasing population, taxes, and social mobility make this solution impractical. The numbers of children to be taught give the teacher little time to observe individual students. Increasing the number of teachers to cope with the increasing number of students runs into the resistance to increasing taxes. High social mobility results commonly in minimal acquaintance of teachers with the past of the individual pupils to be taught. We must, therefore, learn more about the epigenetic developmental hierarchy of learning sets that underlie abilities; we must learn more about the transfer of learning at one level to learning at the next; and we must develop tests to tell us what abilities are present in order to decide what kind of guided learning will profit a given child.

Promising programs can be devised from logical analyses of the abilities and knowledge required to solve various kinds of problems and to learn more under specified conditions. The promise of such programs resides in their apparent immediate success at teaching the skills considered important for the problem and at giving a new ability to solve the problem. This approach is illustrated in the work of Bereiter and Engleman (1966) and of Suchman (1960b) already mentioned. It is also illustrated by a study of Ojemann and Pritchett (1963). These investigators planned a program of experiences designed to inculcate the concept of specific gravity (i.e., the "law of floating bodies" of Archimedes) in children in kindergarten and first grade. They discussed why one should try to figure out why things float, and they presented each child with a floating object and asked why it should or should not float. They examined such answers as "because it is light (or heavy)," "because it is made of plastic (something that floats)," "because it is soft (or hard)," and "because it is big (or little)." The inadequacy of each answer was demonstrated by putting objects into water. It was also demonstrated that when objects are put into water, "the water is pushed away" to make room for the object. This demonstration was followed by another showing that when an object is put into a small vessel of water, the water rises, and that the rise in the water (based on the water pushed away) when weighed has a weight equal to that of the object.

Finally, Ojemann and Pritchett presented a series to test whether each child could estimate (a) which of two objects of differing size would "push away" more water, (b) which of a pair of equal-sized objects would displace more water, (c) which of these objects would weigh more, and (d) which would float, and (e) whether a hollow keg would float after being filled with various materials. Piaget's (1937) early procedures for testing for the conception of specific gravity were also given before and after this guided program of experiences, as well as an alternate set of tests comparable to Piaget's. None of a set of control subjects, who were from the same classes and tested at the same time, changed his stage of understanding as tested by Piaget's tests. But of the nine children of kindergarten age exposed to the guided program of experiences, six exhibited improved understanding of specific gravity. Of these six, one moved three steps (from Stage I to Stage IV of Piaget), three changed by two steps, and two changed by only one step. Why did three fail entirely to profit from this guided program? At least part of the answer should come from an assessment of the intellectual and motivational equipment with which they entered the program. How did the two who changed by only one step differ from the child who changed by three steps? What intellectual and motivational sets are required to help a child profit from such a program? One would guess that none of the culturally-deprived children who became the pupils of Bereiter and Engleman could have profited from the Ojemann-Pritchett program before they had completed the Bereiter-Engleman program. But what about those children who profited much from the latter program? What kinds of new experiences will interest the child who changed by four steps that will not interest the child who failed to change, or the children who changed by only one step with the Ojemann-Pritchett program?

In investigative attempts to answer such questions about the significance of various abilities for children's most profitable experiences, the behavioral evidences of interest and surprise will provide a practical interim solution to the "problem of the match." Encounters with presentations or materials that will not surprise or interest children can be expected to teach them little. Encounters with presentations or materials that frustrate their groping efforts to cope intellectually can be only discouraging. Programs that inculcate merely a memory of verbal material without clear reference to imagery of concrete experiences can result only in language without meaning. But hopefully, properly designed tests of abilities at all levels and properly designed studies of the import of the results of such tests for programs from which children can profit, will lead to quite general solutions of the "problem of the match" — solutions that will then permit teachers to effectively guide learning, even when they must deal with many children about whom they can know almost nothing at first.

If programs for enriching experience during the first two years should prove as effective as, for instance, the results of White and Held (1966) indicate, teachers will also have to change their beliefs about the kinds of experiences appropriate for children of various ages. It is not unlikely that many children could profit from a program like Bereiter and Engleman's, starting as early as their third year. Such children might well be reading for fun and information by age five.

One can dream of a day, perhaps not too far hence if we can soon get psychology and education properly remarried, when the function of a teacher will no longer be a matter of preparing lessons and grading student productions. Instead, she can give tests designed to determine where a child is in the course of his intellectual development or to determine what intellectual and motivational equipment he has. She can then assign him to ready-made programs nicely calculated to promote further development in his own particular intellectual and motivational abilities. Probably many of these ready-made programs will be automated, so that a given child can work on his own or a small group of like-minded young people can work together to solve a new set of problems. When this day comes, the young should not only develop intellectually and motivationally at a more rapid rate, but they should also escape many of the invidious interpersonal comparisons and regularly experience the joy of coping with genuine challenges.

Such schools may be as different from our own as ours are different from the out-loud drill of Chinese schools or from the schools that Martin Luther established to bring the young of the Reformation to salvation by individual access to the Bible. Yet it will take a tremendous amount of psychological investigation and educational development to make such a school real.

PANEL DISCUSSION

FATHER GLENN F. WILLIAMS, *chairman of Group I:* With all this emphasis on speeding up the development of the child, do you believe children will be exposed to too much frustration, thus causing them to miss the experience of childhood and producing adolescents who are unable to create and who are easily bored? Would you be in favor of homogeneous grouping, based on the child's ability to take speed-up?

DR. HUNT: I don't think any child is frustrated by speed-up if — note what follows the *if* — if his rate of growth is a function of an opportunity to encounter what interests him and what surprises him. There is another side of this *if:* if love and affection from parents and teachers are not contingent upon his doing things that he really is not ready to do. In other words, the encouragement of learning — in this instance, the encouragement of maturation — is based upon a control of the situation that the child has an opportunity to encounter.

DR. FRIEDLANDER, *chairman of Group II:* Can the basic information we were talking about have any impact on classroom experience for the teacher and student? Specifically, can curiosity and dissonance motivation to learn be robust enough to stand up against other forces acting on the child? How is a teacher with 25-35 pupils ever able to keep in close contact with the private thought process of the child at the level at which learning takes place?

DR. HUNT: What can the teacher do with 40 children? I find myself getting confused as I think about it, but it isn't entirely hopeless. Think about the first school that Montessori started back in 1907. She undertook her work with about 60 culturally-retarded children from a little under three to seven years of age. The only teacher she had was the 16-year-old daughter of the superintendent of the apartment house. Montessori observed the children, put together materials, and made the teaching operation one of controlling the learning atmosphere. This was not from 10 o'clock to 12 o'clock; it was from 8 in the morning until 6 at night. There were a lot of materials around, and she let the children *literally* do what they wanted to, with one exception: if any child interfered with the others, he had to sit in the corner for awhile. This control was a prohibition on action, on participation. Montessori also provided the situation in which the lock-step in infant education was broken. She arranged a wide variety of materials in the order and level of difficulty. Furthermore, by virtue of having three-to seven-year-olds together, she arranged learning models for the children. The older children taught the younger children. During that first year, some children less than five years old learned to read. This surprised everybody and got across to the world.

Dorothy Canfield Fisher has written what I think is the best introduction to the Montessori method. She observed that the span of attention, which is always considered to be very limited in children, sometimes extended up to two or three hours. She described a child three and one-half years old buttoning and re-buttoning through a two and one-half hour session. The child was learning something here. He started with big buttons and moved to small ones.

About three years ago, Smedslund asked me if I had read a book about Montessori. He said, "You should. She has a solution to your 'problem of the match.' It's not a theoretical solution, but a practical one."

There are some weaknesses in the Montessori approach. One of them is her approach to language. But I think what Bereiter is doing is a corrective method.

In answer to the question about whether curiosity and dissonance motivation are strong enough to overcome the depth of cultural deprivation and other stresses that detract the child from the learning process, I think the answer is "no." In terms of the scale of pre-potency and Maslow's more recent writings, I think there is no question that "the pain of life" dominates even the homeostatic needs. An animal that fears pain will literally starve, and a hungry animal or human is not very interested in sex. Similarly, the purposes and activities that are instrumental to sex will dominate a good many other plans. And other plans will dominate information highlights, the information pattern and novelty. Actually adult and even child motivation is a combination of these relatively independent systems.

Dependency means that getting help from other people has been reinforced (in the Dollard and Miller terms). However, dependency means that the individual is no longer a free agent in terms of curiosity. I find myself, in effect, quite in agreement with Maslow. Ideally, the parent would control the motivation. Perhaps the teacher can control the motivation. For example, a child may want to speak up all the time and may become frustrated because he gets put down in favor of other children. The way to handle this is to explain the nature of causal relationships. There's no use explaining this to a two-year-old, but a three-year-old can learn that he makes daddy mad when he does certain things. I think we must definitely try to teach the nature of causal relationships when dealing with the culturally deprived.

DR. FARLING, *chairman of Group III:* How early do you think formal education should be attempted with children outside the immediate home environment or in formal exposure away from nurturing parents, etc.? Could you say something about the variables in emotional development which affect the degree to which cognitive dissonance can be used? Could you say something about the concept of readiness in terms of individual differences in learning in relation to the sense of emotional security and self-concept?

DR. HUNT: How early formal education can begin, I don't know. I do know this: youngsters who have been to nursery school find the traditional kindergarten a big bore. They're ready to learn to read and to do arithmetic. I suspect that children could even enjoy and profit from the kind of program that Bereiter has at three years of age. It might even be that some children might gain from 20-minute periods at two years of age. There are also children who couldn't function even at four years of age. You notice that in the Ojemann and Pritchett study, there were two children who did not profit from that particular teaching program. Another one jumped three steps. One wonders how these children differ. What are the characteristics of the child? How much plasticity is there?

Concerning security, I think the best I can say is this: if it is not a matter of somebody's approving or disapproving of the child, we don't have to worry about pressure. If the task is tied to approval, you can have plenty of frustration. This kind of situation is a source of distress: the child next door is walking at nine months, and this child is not walking at twelve months. The distress of the parents gets communicated.

Concerning readiness, I would say the whole concept of readiness is not a matter of motivation *per se.* And readiness can decay. I think *interest* is the cue in the readiness factor. It is a matter of what can bring surprise. With this in mind, the readiness factor will take care of itself.

DR. SCHOER: Do you make a distinction between formal and informal education? The question implies that there is, indeed, such a difference. You have some schools of educational thought, such as progressive education, that try to make everything informal.

DR. HUNT: This is true of the Montessori method in a way. The Bereiter method I mentioned is a "no-nonsense" method. But there are only five children per group. I think his is a very effective way of overcoming cultural deprivation, but I don't know whether we're going to get Head Start to hire enough trained teachers to make this kind of thing work. I see another possibility, and that is choosing the kind of technique that the Thomas Edison laboratory is devoted to — educational technology. In our study, mobiles were attached to the cribs so that the children could wiggle them. Actually these children began to develop relationships to those responsive mobiles before the age of three months. The mothers loved them because the babies lay there and kicked to shake the mobiles. Then they laughed. When the mobiles stopped, the babies looked back up and shook their legs to make the mobiles go again. This was a game these infants played before they were three months old.

DR. BARD, *chairman of Group IV:* We are concerned with 1) implementing guided learning with large groups of children and 2) the role of experience in accelerating maturation after age six. Finally, with respect to guided learning generally, where will you begin to make changes in the curriculum, in the area of developmental diagnosis, in the teacher training program, or in all of these at the same time?

DR. HUNT: In the case of the culturally deprived, I think we have to start formal education very early. I don't know much you can do after age six. I am confident there is more capacity than we have ever employed. On the other hand, nobody has really gone about the job of reversing the changes caused by deprivation. For example, when dogs were reared in cages and when a sheep was kept away from other sheep, just ordinary nature did not make the correction. The sheep became non-gregarious.

The culturally deprived child, once he has developed habits and once he's met failure, lacks cognitive growth to cope adequately and he continually meets failure. Something has to be done to reverse the pattern, and I think the earlier the better.

My own suggestion would be a combination of a Montessori day-care center coupled with a few 20-minute periods a week of the Bereiter-type of training. There is real language training brought into his program. Bereiter took youngsters who were at the two to two and one-half year level on the Illinois Test of Psycholinguistic Ability. When he finished they were at a level of five or a little past five. (This test was developed by Kirk and McCarthy and is useful for diagnosis of pre-school children.) These children are going to kindergarten this year, but they are not interested in kindergarten; they're interested in learning. Bereiter plans to take culturally-deprived children from this year's group and put them into schools which are attended by children of professionals. It looks as if they will be equipped to compete. I think if you can get the corrective processes started early enough, you can overcome most of the deprivation. But if deprivation continues too long, it becomes very hard to reverse. I don't know what too long is. We have no parametric study for these questions.

About the question of where to begin changes — begin them all at once.

DR. MERRIFIELD, *chairman of Group V:* How does your notion of intrinsic motivation compare with creating dissonance through making the child aware that the problem exists? How can the teacher be trained to create this dissonance?

DR. HUNT: I think as parents we all try to create dissonance every once in a while. This is where parents run the risk of pushing too hard, of making things difficult. Dr. Kohnstamm remarked yesterday that his learning programs are difficult for the children and for their teachers. When it's difficult, it's probably wrong. The steps ought to be smaller. That doesn't mean you can't — by questions — open up, indicate, point to some things.

Now as far as teacher training and education are concerned, first we need to tie this kind of perceptual approach to the process of development in education. Second, we need to test various kinds of situation to see if the effects we anticipate from the theory are produced. I would like as close to a laboratory situation as possible — not because I find anything wrong with love and human contact — but because the test of the relationships we hypothesize would be to produce some changes without human contact. I would like to test operations through the eyes and ears. I may be wrong. We are a long way from the theory from which you can deduce a practice automatically. The fact is, you have to go back and forth between practice and theory. It is not all cut, dry, and catch.

I wonder about this question of creating dissonance through the material situation with which you confront the child.

DR. KOHNSTAMM: May I interject some comments here? We are not creating dissonance in any systematic way in education, I think. Cognitive-growth people were very interested by Festinger's work and by Berlyne's theoretical extensions of the theory. We are especially interested in curiosity as creating dissonance in his cognitive structure. I don't think, however, we have applied this in education. I had a Montessori education from age four to 18, so I know what it is by heart. I can't remember any instance in which curiosity was created by creating something that didn't fit. Everything fitted, or you could make things fit together without having the feeling of real challenge. If my method of teaching Piagetian problems to pre-operation level children is successful, it is because I brought them to a state of consciousness that something is wrong. I can't find much that education is doing in this respect. It is the "wondering" — the recognition of problems — which makes a good student. You can also teach a child to create his own dissonance.

DR. HUNT: I think Montessori didn't try to make up dissonance. By putting our models arranged in order of complexity, by putting together children of different ages, and by arranging materials according to levels of complexity, she made use of what Piaget called "interest." (He talks about interest as being the subjective side of assimilation.) Charlesworth of Minnesota points out that surprise is the subjective side of accommodation. Surprise can be very motivating.

* * * * *

The conference concluded with a panel discussion led by Ralph H. Ojemann. Discussion treated such broad categories as terminology, various models of learning and information processing, next steps to take in development of a theory, and methods for dissemination of guided learning approaches in schools and teacher training institutions.

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